BOARD OF COUNTY COMMISSIONERS
WARREN COUNTY, OHIO

406 Justice Drive, Lebanon, Ohio 45036
www.co.warren.oh.us
commissioners@co.warren.oh.us

Telephone (513) 695-1250
Facsimile (513) 695-2054

TOM GROSSMANN
SHANNON JONES
DAVID G. YOUNG

ENTER INTO CONTRACT WITH BUILDING CRAFTS, INC. FOR THE RAR WATER TREATMENT PLANT MEMBRANE SOFTENING UPGRADES PROJECT

WHEREAS, pursuant to Resolution #20-0795, adopted June 09, 2020, this Board approved a Notice of Intent to Award Contract for the RAR Water Treatment Plan Membrane Softening Upgrades Project to Building Crafts, Inc., for a total contract price of $22,063,000; and

WHEREAS, all documentation including, performance bonds, insurance certificates, etc., has been submitted by the contractor; and

NOW THEREFORE BE IT RESOLVED, to enter into contract with Building Crafts Inc., for said project, for a total contract price of $22,063,000; as attached hereto and made a part hereof.

Mr. Grossmann moved for adoption of the foregoing resolution being seconded by Mrs. Jones. Upon call of the roll, the following vote resulted:

Mr. Young – yea
Mrs. Jones – yea
Mr. Grossmann – yea

Resolution adopted this 18th day of August 2020.

BOARD OF COUNTY COMMISSIONERS

_____
Tina Osborne, Clerk

KH\

cc: c/a—Building Crafts, Inc.
Water/Sewer (file)
OMB Bid file

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Telephone (513) 695-1250
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TOM GROSSMANN
SHANNON JONES
DAVID G. YOUNG

APPROVE NOTICE OF INTENT TO AWARD BID TO BUILDING CRAFTS, INC. FOR THE RAR WATER TREATMENT PLANT MEMBRANE SOFTENING UPGRADES PROJECT

WHEREAS, bids were closed at 2:00 p.m., June 2, 2020, and the bids received were opened and read aloud for the RAR Water Treatment Plan Membrane Softening Upgrades Project and the results are on file in the Commissioners Office; and

WHEREAS, upon review of such bids by Chris Wojnicz, Warren County Deputy Sanitary Engineer, Building Crafts, Inc., has been determined to be the lowest and best bidder;

NOW THEREFORE BE IT RESOLVED, upon recommendation of Chris Wojnicz, that it is the intent of this Board to award the bid to Building Crafts, Inc., 2 Rosewood Drive, Wilder, Kentucky, for a total bid price of $22,063,000.00; and

BE IT FURTHER RESOLVED, that the Vice President of the Board is hereby authorized to execute a "Notice of Intent to Award."

M. moved for adoption of the foregoing resolution being seconded by M. Upon call of the roll, the following vote resulted:

M
M
M

Resolution adopted this 9th day of June 2020.

BOARD OF COUNTY COMMISSIONERS

_____
Tina Osborne, Clerk

KH\

cc: Water/Sewer (file)
OMB Bid file

WARREN COUNTY
WATER & SEWER DEPARTMENT

CHRIS G. BRAUSCH, P.E.
COUNTY SANITARY ENGINEER

BID OPENING

May 28, 2020

Richard A. Renneker Water Treatment Plant Membrane Softening Upgrades Project

Bids were closed at 2:00 p.m. this 28th day of May and the following bids were received, opened, and read aloud for the Richard A. Renneker Water Treatment Plant Membrane Upgrades Project.

Building Crafts, Inc. Wilder, Kentucky	$22,063,000
Shook Construction Co. Moraine, Ohio	$22,753,500
Dugan & Meyers, LLC Cincinnati, Ohio	$23,183,150
Kokosing Construction Westerville, Ohio	$23,889,000

The Water & Sewer Department along with its consultant team of AECOM and Arcadis will review and evaluate the bids and provide recommendations to the Warren County Board of County Commissioners at a later date.

P. O. BOX 530 ■ 406 JUSTICE DR. ■ LEBANON, OH 45036
513-695-1377 ■ 513-925-1377 ■ 937-425-1377 ■ FAX 513-695-2995
E-MAIL waterdept@co.warren.oh.us

PROJECT MANUAL

WCWSD

MEMBRANE EQUIPMENT
PROCUREMENT

ISSUED FOR BID

April 1, 2020
Project No. 60551697

277 WEST NATIONWIDE BOULEVARD
COLUMBUS, OHIO 43215-2566
Tel 614.464.4500
Fax 614.464.0588

SECTION 00 0101

PROJECT TITLE PAGE

Title and Location of Work:

Warren County Water & Sewer Department (WCWSD)
Membrane Equipment Procurement

Richard A. Renneker Water Treatment Plant (RARWTP)
Membrane Softening Upgrades
6193 Striker Road
Maineville, OH 45036

Franklin Area Water Treatment Plant (FAWTP)
Membrane Softening Upgrades
6648 Shelly Street
Franklin, OH 45005

Name and Address of Owner:

Warren County Water and Sewer District
406 Justice Drive
Lebanon, OH 45036

Name and Address of Engineer:

AECOM
277 West Nationwide Boulevard
Columbus, OH 43215-2566
Telephone: 614-464-4500
Fax: 614-464-0588
Email:
matthew.noelker@aecom.com

END OF SECTION 00 0101

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SECTION 00 0110

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VOLUME 1

PROCUREMENT AND CONTRACTING DOCUMENTS GROUP

SPECIFICATIONS GROUP

General Requirements Subgroup

Facility Construction Subgroup

Process Equipment Subgroup

END OF SECTION 00 0110

SECTION 00 1113

ADVERTISEMENT FOR BIDS

SECTION 1 – INTRODUCTION/OVERVIEW

Objective/Background/Definitions

On behalf of the Warren County Water and Sewer Department (WCWSD) (Owner), AECOM (Engineer) is inviting you to submit a Bid for furnishing the goods and services described in this Advertisement for Bids. The purpose of this request is to solicit Bids from Original Equipment Manufacturers (OEMs) (Sellers) for the purpose of selecting an OEM prior to the bidding of the construction projects. The Engineer will act as the Owner's representative during this bidding process.

AECOM is the design engineer for two water treatment plant projects—the Richard A. Renneker Water Treatment Plant (RARWTP) and the Franklin Area Water Treatment Plant (FAWTP). Both projects are in Warren County, Ohio. The RARWTP construction contract is anticipated to bid in May 2020. The FAWTP construction contract is anticipated to be bid in June 2020. It is anticipated that each of these Contracts will be awarded by the end of August 2020. The General Contractors (Buyers) who are awarded these construction contracts will become the Buyers. The pricing information provided by the Bidder will be used to determine the Contract Price between the Seller and the Buyers. The RARWTP and FAWTP construction projects are being bid separately, and as such, the Seller will have to enter into Contract with up to two separate Buyers.

This solicitation does not constitute an offer by the Owner or the Engineer to enter into a contract with the Bidder. The terms of the Bid and resulting agreement shall comply with all applicable federal, state, and local laws.

SECTION 2 – BID INSTRUCTIONS AND REQUIREMENTS

Submission of Bids

Bids will be received by Engineer until May 15, 2020 @ 2:00 p.m Bids shall be submitted via email or via hand delivery, USPS, UPS, or FedEx to:

AECOM
ATTN: Matthew Noelker, P.E.
277 West Nationwide Blvd
Columbus, Ohio 43215
Matthew.noelker@aecom.com

Compliance with the Request for Bid

Bids shall be submitted in strict compliance with this Request for Bid. Failure to comply with all provisions of the Request for Bid may result in disqualification.

Inquiries

Any questions related to this Request for Bid shall be directed to:

Matthew Noelker
matthew.noelker@aecom.com
614-600-5980

Inquiries shall be received at least five (5) working days prior to the Bid due date. Responses to inquiries will only be official and binding where issued in a formal written addendum.

Ambiguity, Confliction, or Other Errors in the Request for Bid

If a Bidder discovers any ambiguity, conflict, discrepancy, omission, or other error in the Request for Bid or any document attached to, incorporated into, or referenced by the Request for Bid, they shall immediately notify the Engineer of such error in writing and request modification or clarification of the document. Modifications, where required, will be made by issuance of a written addendum. All parties who have received this Request for Bid from the Engineer will receive addenda. Failure of Bidders to receive or acknowledge any addendum shall not relieve them of any obligation under this Request for Bid. All addenda shall become part of this Bid.

Bid and Presentation Costs

The Owner and Engineer will not be liable in any way for any costs incurred by any Bidder in the preparation of its Bid in response to this Request for Bid, nor for the presentation of its Bid and/or participation in any discussions or negotiations.

Rejection of Bids

The Engineer reserves the right to accept or reject any or all Bids submitted. Reasons for which Bidders may be disqualified and their Bids not considered include, but are not limited to:

- The Engineer determines that the Bid is non-responsive to the Advertisement for Bid.
- The Engineer determines that the Bid is not in the Owner's best interest.
- The Bidder fails to complete the Bid in its entirety in response to this Advertisement for Bid.
- Reasonable grounds existing for believing that any Bidder has a proprietary or pecuniary interest in more than one Bid, or that collusion exists among the Bidders.
- Failure of the Bidder to satisfy any requirements of the Advertsiement for Bid.

Engineer's Right to Research Bidder's Experience

The Engineer, prior to or after receipt of the Bid, shall have the right to research work performed by the Bidder. This research effort will be conducted by the Engineer, as deemed appropriate, and may include site visits and interview with anyone involved with such projects.

The Engineer reserves the right to contact any and all references (including those not furnished by the Bidder in their Bid) to obtain, without limitation for the purpose of evaluating the Proper's qualification, the following minimum information regardless of Bidder's performance on the listed jobs:

- Was Bidder cooperative during the submittal process (e.g., negotiation of scope of supply, schedule,

shop drawings, etc.)?
- Did Bidder effectively address problems that arose during the project?
- Did Bidder address warranty and punch list items in a timely manner?
- Were Bidder's project manager, commissioning supervisor, and other key personnel competent and professional?
- Was the Owner satisfied with the finished product?
- Were there any issues related to project schedule at any point in the project, including design, construction, startup and commissioning, as a result of the Bidder's design submittals, Bidder's equipment supplied on the project, or the Bidder's personnel involved in the startup and commissioning of the project?
- Were there any claims or disputes initiated by or involving the Bidder associated with procurement, implementation, or startup of the Bidder's equipment supplied on the project?

Terms and Conditions

The Agreement resulting from this Request for Bid shall be subject to the conditions set forth in the Engineers Joint Contract Documents Committee (EJCDC) procurement documents, as amended, including the "Agreement between Buyer and Seller for Procurement Contracts", and the "Standard General Conditions for Procurement Contracts".

Terms of payment shall be in accordance with the "Standard General Conditions for Procurement Contracts" and the "Agreement between Buyer and Seller for Procurement Contracts".

The Bidder's standard preprinted terms and conditions will not be accepted as a substitute to the above referenced EJCDC procurement documents. Should the Bidder request modification to EJCDC procurement documents terms and conditions, they shall make a written request to the Engineer at least five (5) days prior to the Bid due date. Any accepted modifications will be addressed in an Addendum.

SECTION 3 – BID EVALUATION AND SELECTION

Consideration of Bids

Properly Identified Bids receveived on time will be publicly opened and read aloud.

The Engineer reserves the right to reject any or all Bids, and shall have no liability whatsoever to any Bidder whose Bid is not accepted. Bid Packages containing irregulatities, conditional or obscure language, or addtions not requested by the Bidding Documents may be rejected.

Acceptance of a Bid will not constintue an Agreement between thw Engineer or the Owner and the Bidder, and will not be binding unless and untl an Agreement coverimng all conditions and prvisions of the Work have been reduced to writing and excuted by the Buyer and the Seller.

All alternates are mandatory.

Low bidder will be determined by base bid, plus/minus any selected alternates. The Engineer reserves the right to request clarifications and/or corrections to Bids. Once the evaluation is complete, all responsive Bids will be ranked and the Bidder with the lowest total cost will be selected.

The Engineer will then issue the selected Bidder "Notice of Tentative Selection" indicating that, subject to the award of the general construction contracts, the Bidder's equipment and pricing will be incporated into the Project as the Basis of Design, and will be included in the the Construction Contract Documents.

Price

The Bidder shall complete the Itemized Price Proposal (Division 00, Section "Bid Form", Article 4) as part of their Bid.

Submittal of Bid indicates that the Bidder has a full understanding of the scope of work based upon a review of all information furnished with this Request for Bid. The prices entered shall reflect the scope of work requested in this Request for Bid, including any additive and deductive alternates, based on the requirements of this Request for Bid.

Projected Timeline of Deliverables

The Bidder shall complete the Proposed Project Schedule (Division 00, Section "Bid Form", Article 5).

SECTION 4 – BID FORMAT AND CONTENTS

General

The information listed below shall be submitted with each Bid and shall be submitted in the order shown. Each section must be clearly labeled the section titles below.

Bid Form

The Bidder shall complete and submit the Bid Form (Division 00, Section "Bid Form") included with this Request for Bid. The Bid Form includes the Bidder's Cost (Article 4) and Schedule (Article 5).

Attachments

Attachment 1: Bidder Qualifications

Bidder shall provide a list of at least four (4) projects of similar size (permeate capacity of at least 5 MGD) and scope previously completed and in operation. Information for each project shall be provided on the Bidder's Qualifications Form (Division 00, Section "Bidder's Qualifications") provided with this Request for Bid or a reasonably similar form provided by the Bidder. The Bidder make additional copies of the form as required. Only one project shall be listed on each form. All information requested in the form shall be provided in the order requested.

Attachment 2: Scope of Supply

The Bidder shall submit a detailed description of their scope of supply, including the name of the component manufacturer of all equipment supplied. Any exceptions to or deviations from the requirements of this Request for Bid shall clearly be described.

The System Manufacturer shall consider the cost of items required in this Request for Bid and whether some scope tems would be more cost effective if provided by the Contractor or different component manufacturer

than specified. Provide itemized price deductions for these items along with a description of alternate scope of supply.

Attachment 3: OEM Special Services

Bidder shall include a description of all OEM Special Services, per the requirements listed in Division 43, Section "Nanofiltration Membrane Equipment".

Attachment 4: OEM Warranty

Bidder shall include a description of the proposed warranty, per the requirements listed in Division 43, Section "Nanofiltration Membrane Equipment".

Attachment 5: Installation Instructions and Contractor's Responsibilities

Bidder shall include details regarding the Contractor's scope of work for Bidder supplied equipment. Include unloading, mounting, and installation instructions specifically noting any field assembly that is required. Include a list of any required components not included in the System Manufacturer's scope of supply that must be provided by the Contractor. Also include requirements for installation checklists and support during commissioning.

Attachment 6: Spare Parts

Bidder shall include a list and description of all spare parts, per the requirements listed in Division 43, Section "Nanofiltration Membrane Equipment".

END OF SECTION 00 1113

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SECTION 00 4113

BID FORM

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ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to the Engineer via email or via hand delivery, USPS, UPS, or FedEx to:

AECOM
ATTN: Matthew Noelker, P.E.
277 West Nationwide Blvd
Columbus, Ohio 43215
Matthew.noelker@aecom.com

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Buyer in the form included in the Bid Documents to furnish the Goods and Special Services as specified or indicated in the Bid Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bid Documents.

1.03 The Buyer of the Goods and Special Services will be the successful Bidder(s) (Contractor(s)) for the referenced Projects.

ARTICLE 2 – BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the RFP.

2.02 Bidder accepts the provision of the Agreement as to liquidated damages in event of its failure to furnish the Goods and Special Services in accordance with the schedule set forth in the Agreement.

ARTICLE 3 – BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bid Documents included with the RFP, other related data identified, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date

B. Bidder has become familiar with and is satisfied as to the local conditions that may affect cost, progress, delivery, or the furnishing of Goods and Special Services.

C. Bidder is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress, and the furnishing of Goods and Special Services.

D. Bidder has carefully studied and correlated the information known to Bidder, and information and observations obtained from Bidder's visits, if any, to the Point of Destination with the Bid Documents.

E. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bid Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

F. The Bid Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing the Goods and Special Services for which this Bid is submitted.

G. Bidder further represents that this Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any individual or entity to refrain from Bid; and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Buyer.

ARTICLE 4 – BASIS OF BID

4.01 Bidder will furnish the Goods and Special Services in accordance with these Contract Documents for the following price(s), which do not include sales tax. Prices shall be guaranteed until August 31, 2020. After this date, if requested by the Buyer and approved by the Owner, Buyer's proposed prices may be escalated by the monthly change of the U.S. Consumer Price Index (CPI) as calculated by the U.S. Bureau of Labor Statistics.

RARWTP

Item No.	Description	Proposed Price
	SHOP DRAWINGS	
1.)	Shop Drawing Preparation	
	EQUIPMENT	
2.)	Base Bid: Manufacturing of Goods—Epoxy Coated or FRP Frames Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	
3.)	Base Bid: Assembly of Goods Onsite—Epoxy Coated or FRP Frames Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power.	
4.)	Alternate Bid: Manufacturing of Goods—304 SST Frames (Item cost is additive or deductive from Item No. 2). Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 5.	Add / Deduct (Circle One)
5.)	Alternate Bid: Assembly of Goods Onsite—304 SST Frames (Item cost is additive or deductive from Item No. 3). Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power.	Add / Deduct (Circle One)
	SPECIAL SERVICES	
6.)	Include costs required for all Special Services including startup and commissioning, remote monitoring, and field service agreement.	

FAWTP

Item No.	Description	Proposed Price
	SHOP DRAWINGS	
7.)	Shop Drawing Preparation	
	EQUIPMENT	
8.)	Base Bid: Manufacturing of Goods—Epoxy Coated or FRP Frames Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 9.	
9.)	Base Bid: Assembly of Goods Onsite—Epoxy Coated or FRP Frames Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power.	
10.)	Alternate Bid: Manufacturing of Goods—304 SST Frames (Item cost is additive or deductive from Item No. 8). Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 11.	Add / Deduct (Circle One)
11.)	Alternate Bid: Assembly of Goods Onsite—304 SST Frames (Item cost is additive or deductive from Item No. 9). Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power.	Add / Deduct (Circle One)
	SPECIAL SERVICES	
12.)	Include costs required for all Special Services including startup and commissioning, remote monitoring, and field service agreement.	

TOTALS

RARWTP TOTAL LUMP SUM BASE BID
(1 + 2 + 3 + 6):

_____ Dollars $_____
(Words) (Figures)

RARWTP TOTAL LUMP SUP ALTERNATE BID
(1 + 2 + 3 + 4 + 5 + 6):

_____ Dollars $_____
(Words) (Figures)

FAWTP TOTAL LUMP SUM BASE BID
(7 + 8 + 9 + 12):

_____ Dollars $_____
(Words) (Figures)

FAWTP TOTAL LUMP SUP ALTERNATE BID
(7 + 8 + 9 + 10 + 11 + 12):

_____ Dollars $_____
(Words) (Figures)

TOTAL LUMP SUM BASE BID (RARWTP + FAWTP)

_____ Dollars $_____
(Words) (Figures)

TOTAL LUMP SUP ALTERNATE BID (RARWTP + FAWTP)

_____ Dollars $_____
(Words) (Figures)

4.02 Additional Proposed Costs:

Description	Proposed Price
The Seller's monthly fee for storage of Goods at Seller's facilities in the event that Buyer desires to delay shipment beyond the shipment date stated below in Article 5.02. Such fee shall include interest on money due Seller.	
The Seller's monthly fee for Buyer delaying the initiation of manufacturing of Goods or for not executing the Procurement Agreement within the time specified in 4.03 below.	

4.03 Seller and Buyer shall execute the Procurement Agreement within 30 days after the Contractor's/Buyer's Notice to Proceed from the Owner. Should the Procurement Agreement not be executed within said 30 days due to the fault of the Buyer, the Buyer shall be subject to the prorated additional costs identified in Paragraph 4.02 above. Should the Procurement Agreement not be executed within the said 90 days due to the fault of the Seller, Seller shall be subject to the liquidated damages provisions in the Procurement Agreement. The issue of fault will be determined by the Engineer.

ARTICLE 5 – TIME OF COMPLETION

5.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedules set forth below, which will be incorporated into Article 5 of the Agreement.

Description:	Proposed Number of Consecutive Calendar Days:
Time required by Seller to submit approvable Shop Drawings (consecutive calendar days after Notice to Proceed is issued to Buyer)	
Time required by Seller after receipt of approved Shop Drawings to deliver acceptable Goods to Point of Destination: (consecutive calendar days)	
Time required by Seller to complete assembly of goods onsite (exclude time for unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power)	
Time required by Seller to complete all Special Services (consecutive calendar days after notification from Buyer to Seller to commence such Special Services.):	
Time required by Seller to be ready for Final Inspection and Acceptance of all Goods and all Special Services (consecutive calendar days after notification from Buyer to Seller to commence such Special Services.):	

5.02 Bidder agrees that the prices in Article 4 above are based on the condition that shipment of goods may be delayed by the Buyer.

ARTICLE 6 – BID DOCUMENTS

6.01 The following documents are attached with and made a condition of this Bid:

A. Attachment 1: Bidder Qualifications

B. Attachment 2: Scope of Supply

C. Attachment 3: OEM Special Services

D. Attachment 4: OEM Warranty

E. Attachment 5: Installation Instructions and Contractor's Responsibilities

F. Attachment 6: Spare Parts

ARTICLE 7 – DEFINED TERMS

7.01 The terms used in this Bid have the meanings indicated in the General Conditions. The significance of terms with initial capital letters is described in the General Conditions.

ARTICLE 8 – BID SUBMITTAL

8.01 This Bid is submitted by:

If Bidder is:

A Partnership

Partnership Name: _____

By: _____
(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed): _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____
Type (General Business, Professional, Service, Limited Liability):_____

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____
(CORPORATE SEAL)

Attest _____

Date of Qualification to do business in Ohio is ____/____/____.

A Joint Venture

Name of Joint Venture: _____

First Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of first joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Second Joint Venturer Name: _____(SEAL)

By: _____
(Signature of second joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

Bidder's Business Address _____

_____

Phone No. _____ Fax No. _____

E-mail _____ _____

SUBMITTED on _____, 20____.

END OF SECTION 00 4113

SECTION 00 4390

BIDDER'S CHECKLIST

DISCLAIMER - This checklist is not intended to relieve the Proposer of the responsibility to provide other required documents. Rather, this checklist is offered merely to serve as an aid in assisting in the preparation of the Proposal. Notice is hereby given that the failure to submit all required documents duly and properly completed including but not limited to all required signatures may result in the rejection of your bid on the basis that the bid is non-responsive.

PROPOSAL FORMS (PROVIDED)

- ☐ Advertisement for Bids, Section 00 1113 (for information only)
- ☐ Bid Form, Section 00 4113
- ☐ Attachment 1: Bidder's Qualifications, Section 00 4513 (complete for at least 4 projects)
- ☐ Attachment 2: Scope of Supply
- ☐ Attachment 3: OEM Special Services
- ☐ Attachment 4: OEM Warranty
- ☐ Attachment 5: Installation Instructions and Contractor's Responsibilities
- ☐ Attachment 6: List of Spare Parts

END OF SECTION 00 4390

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SECTION 00 4513

BIDDER' QUALIFICATIONS

At the time of bid, the Bidder is required to provide detailed information on the form herein (or referenced and attached hereto) as evidence of the Bidder's responsibility, experience, and skill to complete the project in the time allotted. This information will be used by the Engineer to determine if the Bidder is the lowest responsible and responsive Proposal. The Engineer may make related investigations to determine the ability of the Bidder to perform the work. The Bidder shall furnish to the Engineer, in a timely manner, all such information and data as the Engineer may request for this purpose.

Project Name	
Project Location (City, State)	
Owner's Name	
Owner's Contact Name and Title	
Owner's Contact Email and Phone Number	
Design Engineering Firm Name	
Design Engineer's Contact Name and Title	
Design Engineer's Contact Email and Phone Number	
Construction Start/Completion Date	
OEM Scope of Supply	
Major Process Design Parameters (flux, recovery, etc.)	
Type of Membranes Used	
Total Capacity of Membrane System	
Number of Skids	
Raw Water Source	

END OF SECTION 00 4513

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This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

AGREEMENT BETWEEN BUYER AND SELLER FOR PROCUREMENT CONTRACT

Prepared By

EJCDC®
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

ACEC
AMERICAN COUNCIL OF ENGINEERING COMPANIES

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

NSPE®
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

AGREEMENT BETWEEN BUYER AND SELLER FOR PROCUREMENT CONTRACT

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AGREEMENT BETWEEN BUYER AND SELLER FOR PROCUREMENT CONTRACT

This Procurement Agreement is by and between **[formal name of entity]** ("Buyer") and **[formal name of entity]** ("Seller").

Terms used in this Procurement Agreement have the meanings stated in the General Conditions of the Procurement Contract and the Supplementary Conditions of the Procurement Contract.

Buyer and Seller hereby agree as follows:

ARTICLE 1—PROCUREMENT CONTRACT

1.01 *Goods and Special Services*

A. Seller shall furnish the Goods and Special Services as specified or indicated in the Procurement Contract Documents. The Goods and Special Services are generally described as follows: membrane softening equipment for two (2) water treatment plants.

1.02 *The Project*

A. The Project, of which the Goods and Special Services are a part, is generally described as follows: membrane softening upgrades at two (2) water treatment plants.

1.03 *Engineer*

A. Buyer has retained **AECOM** ("Engineer"), to prepare Procurement Contract Documents and act as Buyer's representative. Engineer assumes all duties and responsibilities and has the rights and authority assigned to Engineer in the Procurement Contract Documents in connection with Seller's furnishing of Goods and Special Services.

1.04 *Point of Destination(s)*

A. The Point of Destinations are designated as:

RARWTP, 6193 Striker Road, Maineville, Ohio 45039

FAWTP, 6648 Shelly Street, Franklin, Ohio 45005

ARTICLE 2—PROCUREMENT CONTRACT TIMES

2.01 *Time of the Essence*

A. All time limits for Milestones, including the submittal of Shop Drawings and Samples, the delivery of Goods, and the furnishing of Special Services as stated in the Procurement Contract Documents, are of the essence of the Procurement Contract.

2.02 *Schedule of Procurement Contract Times*

A. The following schedule sets forth the Procurement Contract Times:

Milestone	Days
Submit approvable Shop Drawings	**[insert days from attached bid form]**
Deliver acceptable Goods to Point of Destination	**[insert days from attached bid form]**
Complete assembly of goods onsite (if required)	**[insert days from attached bid form]**
Complete Special Services	**[insert days from attached bid form]**
Readiness for Final Inspection and Acceptance of Goods and Special Services	**[insert days from attached bid form]**

2.03 *Shop Drawings and Samples*

A. *Submittal of Shop Drawings and Samples*: Seller shall submit all Shop Drawings and Samples required by the Procurement Contract Documents to Engineer for its review and approval.

B. *Engineer's Review*: It is the intent of the parties that Engineer will conduct its review of Shop Drawings and Samples and issue its approval, or a denial accompanied by substantive comments regarding information needed to gain approval, within 14 working days after Seller's submittal of such Shop Drawings and Samples, or within such longer period that is needed because of the quantity and quality of such submittals. Resubmittals will be limited whenever possible.

2.04 *Liquidated Damages*

A. Buyer and Seller recognize that time is of the essence as stated in Paragraph 2.01, and that Buyer will suffer financial and other losses if the Goods are not delivered to the Point of Destination and ready for receipt of delivery by Buyer within the time specified in Paragraph 2.02, plus any extensions thereof allowed in accordance with this Procurement Contract. The parties also recognize that the timely performance of services by others involved in the Project is materially dependent upon Seller's specific compliance with the delivery requirements of Paragraph 2.02. Further, the parties recognize the time, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the loss (whether direct, consequential, or otherwise) suffered by Buyer if complete, acceptable Goods are not delivered on time. Accordingly, instead of requiring any such proof, Buyer and Seller agree that as liquidated damages for delay (but not as a penalty) Seller shall pay Buyer $1,000 for each day that expires after the time specified in Paragraph 2.02 for delivery of acceptable Goods.

B. Liquidated damages for failing to timely attain Milestones are not additive, and will not be imposed concurrently.

ARTICLE 3—PROCUREMENT CONTRACT PRICE

3.01 *Procurement Contract Price and Total Price—Based on Attached Bid*

A. For furnishing the Goods and Special Services in accordance with the Procurement Contract Documents, Buyer shall pay Seller the prices stated in Seller's Bid, attached hereto as an exhibit, subject to final adjustments for Unit Price Goods and Special Services and Buyer's Contingency Allowance, if any, and subject to the following Buyer-accepted alternates: **[identify accepted alternates, if any]**.

ARTICLE 4—PAYMENT PROCEDURES

4.01 *Submittal and Processing of Applications for Payment*

A. Seller shall submit Applications for Payment in accordance with Article 13 of the General Conditions and the following paragraphs. Engineer and Buyer will process such Applications for Payment in accordance with said Article 13.

4.02 *Progress Payments; Final Payment*

A. Seller may submit an Application for Payment requesting the stated amounts upon attainment of each of the following Payment Line Items:

Payment Line Item	Minimum or Maximum Percentage of Lump Sum
1. Receipt of Approval of Shop Drawings	10% maximum
2. Completion of Acceptance Testing	5% maximum
3. Delivery of Goods to Point of Destination in accordance with the Procurement Contract Documents	
4. Completion of assembly of goods onsite	
5. Completion of Special Services	10% minimum
6. Final Payment: Correction of non-conformities, acceptance of final Operation and Maintenance Manuals, submittal of all final documentation required	5% minimum

B. Buyer shall pay Seller the amount owed under an Application for Payment within 30 days after Engineer's presentation to Buyer of the Application for Payment and Engineer's recommendation.

4.03 *Interest*

A. All amounts not paid when due will bear interest as the rate of six percent per annum.

ARTICLE 5—ASSIGNMENT OF PROCUREMENT CONTRACT

5.01 *Assignment of Contract*

A. No assignment by a party hereto of any rights under or interests in the Procurement Contract will be binding on another party hereto without the written consent of the party sought to be bound. Specifically, but without limitation, Procurement Contract payments or other money that may become due, and Procurement Contract payments or other money that are

due, may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by Laws and Regulations). Unless specifically stated to the contrary in any written consent to such an assignment, such an assignment will not release or discharge the assignor from any duty or responsibility under the Procurement Contract Documents.

ARTICLE 6—PROCUREMENT CONTRACT DOCUMENTS

6.01 *List of Procurement Contract Documents*

A. The Procurement Contract Documents consist of the following:

1. This Procurement Agreement.
2. General Conditions of the Procurement Contract.
3. Procurement Specifications as listed in the Procurement Specifications table of contents.
4. Procurement Drawings consisting of the Drawings listed on the sheet index.
5. Addenda Numbers.
6. Exhibits to this Procurement Agreement (enumerated as follows):
    a. Seller's Bid (and all attachments)
    b. Documentation submitted by Seller prior to Notice of Award.
7. The following which may be delivered or issued on or after the Effective Date of the Procurement Contract and are not attached hereto:
    a. Change Orders;
    b. Change Directives; and
    c. Field Orders.

B. The documents listed in Paragraph 6.01.A are incorporated into this Procurement Agreement by reference.

C. There are no Procurement Contract Documents other than those listed above.

D. The Procurement Contract Documents may only be amended or supplemented as provided in Paragraph 11.01 of the Procurement General Conditions.

ARTICLE 7—SELLER'S REPRESENTATIONS AND CERTIFICATIONS

7.01 *Seller's Representations*

A. In order to induce Buyer to enter into this Procurement Agreement, Seller makes the following representations:

1. Seller has examined and carefully studied the Procurement Contract Documents.
2. If required by the Instructions to Bidders to visit the Point of Destination and the site where the Goods are to be installed or Special Services will be provided, or if, in Seller's judgment, any observable local or site conditions may affect the delivery, cost, progress,

or furnishing of the Goods and Special Services, then Seller has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided (as applicable) and become familiar with and is satisfied as to the observable local and site conditions that may affect delivery, cost, progress, and furnishing of the Goods and Special Services.

3. Seller is familiar with and is satisfied as to all Laws and Regulations that may affect the cost, progress, and performance of Seller's obligations under the Procurement Contract.

4. Seller has carefully studied, considered, and correlated the information known to Seller with respect to the effect of such information on the cost, progress, and performance of Seller's obligations under the Procurement Contract.

5. Seller has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Seller has discovered in the Procurement Contract Documents, and the written resolution (if any) thereof by Engineer is acceptable to Seller.

6. The Procurement Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance of Seller's obligations under the Procurement Contract.

7. Seller's entry into this Procurement Contract constitutes an incontrovertible representation by Seller that without exception all prices in the Procurement Agreement are premised upon furnishing the Goods and Special Services as required by the Procurement Contract Documents.

7.02 *Seller's Certifications*

A. Seller certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Procurement Contract. For the purposes of this Paragraph 7.02:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Procurement Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Procurement Contract to the detriment of Buyer, (b) to establish bid or contract prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Procurement Contract.

ARTICLE 8—CONFIDENTIALITY

8.01 *Confidential Information*

A. Confidential information is information in documents submitted by Seller that Seller clearly and prominently labels in writing to be a trade secret, proprietary, or confidential. Such documents, if any, will be maintained in a manner that endeavors to avoid disclosing confidential information to third parties, to the extent allowed by Laws and Regulations.

B. Seller shall clearly and prominently mark confidential information with the word "CONFIDENTIAL" on each page or sheet or on the cover of bound documents. Place "CONFIDENTIAL" stamps or watermarks so that they do not obscure any of the required information on the document, either in the original or in a way that would obscure any of the required information in a photocopy of the document.

8.02 *Disclosure of Confidential Information*

A. If Buyer is requested to disclose confidential information, or becomes legally compelled (by oral questions, interrogatories, requests for information or documents, subpoena, civil or criminal investigative demand, public information requests, or other requests under Laws and Regulations) to disclose confidential information, or is required by a regulatory body, governing agency, or controlling authority to disclose confidential information, or make any other disclosure that is prohibited or otherwise constrained by the Procurement Contract, Buyer will provide Seller with prompt notice so Seller may seek an appropriate protective order or other remedy. Seller will be solely responsible for submitting to the regulatory body, governing agency, or controlling authority any arguments, briefs, memoranda, motions, authorities, or other information in opposition to disclosure.

B. Buyer's obligations with respect to confidential information are nullified by the following exceptions:

1. Confidential information becomes a part of the public domain through publication or otherwise, through no fault of the Buyer;

2. Buyer can demonstrate through suitable documentation that the confidential information was already in the Buyer's possession, and not previously marked as confidential, or was otherwise publicly available prior to the Effective Date of the Procurement Contract;

3. The confidential information is subsequently and independently disclosed to the Buyer by a third party who has a lawful right to disclose such information;

4. Buyer has a good faith belief that disclosure is required or justified; or

5. Buyer is required to disclose the confidential information by court order or by applicable Laws and Regulations.

8.03 *Waiver of Immunity*

A. Notwithstanding any other provision of the Procurement Contract, it is stipulated and agreed that by accepting confidential information, Buyer has not and does not waive its legal immunity (if any) from suit or liability.

ARTICLE 9—MUTUAL WAIVER

9.01 *Mutual Waiver of Consequential Damages*

A. Buyer and Seller waive against each other, and against the other's officers, directors, members, partners, employees, agents, consultants, and subcontractors, any and all claims for or entitlement to incidental, indirect, or consequential damages arising out of, resulting from, or related to the Procurement Contract. If Buyer (Project Owner) assigns this Procurement Contract to a construction contractor (Contractor/Assignee), then the terms of this Paragraph 9.01.A will be binding upon the Contractor/Assignee with respect to Seller and assignor. The terms of this mutual waiver do not apply to or limit any claim by either Buyer or Seller against the other based on any of the following: (a) contribution or indemnification, (b) liquidated damages, (c) costs, losses, or damages attributable to personal or bodily injury, sickness, disease, or death, or to injury to or destruction of the tangible property of others, (d) intentional or reckless wrongful conduct, or (e) rights conferred by any bond provided by Seller under this Procurement Contract.

IN WITNESS WHEREOF, Buyer and Seller have signed this Procurement Agreement. Counterparts have been delivered to Buyer and Seller.

The Effective Date of the Procurement Contract is **[date to be inserted at the time of execution]**.

Buyer	Seller
_____ *(typed or printed name of organization)*	_____ *(typed or printed name of organization)*
By: _____ *(individual's signature)*	By: _____ *(individual's signature)*
Date: _____ *(date signed)*	Date: _____ *(date signed)*
Name: _____ *(typed or printed)*	Name: _____ *(typed or printed)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)* *(If Seller is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)*
Attest: _____ *(individual's signature)*	Attest: _____ *(individual's signature)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)*
Address for giving notices:	Address for giving notices:
_____	_____
_____	_____
_____	_____
Designated Representative:	Designated Representative:
Name: _____ *(typed or printed)*	Name: _____ *(typed or printed)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)*
Address:	Address:
_____	_____
_____	_____
_____	_____
Phone: _____	Phone: _____
Email: _____ *(If Buyer is a corporation, attach evidence of authority to sign. If Buyer is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)*	Email: _____

SECTION 00 7000

GENERAL CONDITIONS

Following is Standard General Conditions of the Procurement Contract (NSPE – EJCDC P-700, 2019 Edition).

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This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS OF THE PROCUREMENT CONTRACT

Prepared By

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ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

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STANDARD GENERAL CONDITIONS OF THE PROCUREMENT CONTRACT

TABLE OF CONTENTS

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Whenever used in the Procurement Bidding Requirements or Procurement Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated, which are applicable to the singular or plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Procurement Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Procurement Contract Documents.

2. *Application for Payment*—The document prepared by Seller, in a form acceptable to Buyer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Procurement Contract Documents.

3. *Bid*—An offer or proposal of a prospective Seller submitted on the prescribed form setting forth the prices for the Goods and Special Services to be provided.

4. *Bidder*—An individual or entity that, as a prospective Seller, submits a Bid to Buyer.

5. *Buyer*—The individual or entity purchasing the Goods and Special Services.

6. *Change Directive*—A written directive from Buyer to Seller issued on or after the Effective Date of the Procurement Contract, ordering an addition, deletion, or revision in the Goods and Special Services.

7. *Change Order*—A document which is signed by Seller and Buyer and authorizes an addition, deletion, or revision to the Procurement Contract Documents or an adjustment in the Procurement Contract Price or the Procurement Contract Times, issued on or after the Effective Date of the Procurement Contract. Change Orders may be the result of mutual agreement by Buyer and Seller, or of resolution of a Claim.

8. *Claim*—A demand or assertion by Buyer or Seller seeking an adjustment of Procurement Contract Price or Procurement Contract Times, or both, or other relief with respect to the terms of the Procurement Contract. A demand for money or services by a third party is not a Claim.

9. *Contractor/Assignee*—A construction contractor with which Project Owner enters into a construction contract, and to which Project Owner, as initial Buyer, assigns this Procurement Contract.

10. *Effective Date of the Procurement Contract*—The date indicated in the Procurement Agreement on which the Procurement Contract becomes effective.

11. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.

12. *Electronic Means*—Electronic mail (e-mail), upload/download from a secure Project website, or other communications methods that allow: the transmission or communication of Electronic Documents; the documentation of transmissions, including sending and receipt; printing of the transmitted Electronic Document by the recipient; the storage and archiving of the Electronic Document by sender and recipient; and the use by recipient of the Electronic Document for purposes permitted by this Procurement Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

13. *Engineer*—The individual or entity designated as such in the Procurement Agreement.

14. *Field Order*—A written order issued by Engineer which requires minor changes in the Goods or Special Services, but which does not involve a change in the Procurement Contract Price or Procurement Contract Times.

15. *Goods*—The tangible and movable personal property that is described in the Procurement Contract Documents, regardless of whether the property is to be later attached to realty.

16. *Goods and Special Services*—The full scope of materials, equipment, other items, and services to be furnished by Seller, including Goods, as defined herein, and Special Services, if any, as defined herein. This term refers to both the Goods and the Special Services, or to either the Goods or the Special Services, and to any portion of the Goods or the Special Services, as the context requires.

17. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

18. *Milestone*—A principal event specified in the Procurement Contract that Seller must attain by the date or within the number of days indicated, including but not limited to the delivery of the Goods and the furnishing of Special Services.

19. *Notice of Award*—The written notice, by Buyer to a Bidder, of Buyer's acceptance of the Bid.

20. *Point of Destination*—The specific address of the location where delivery of the Goods will be made, as stated in the Procurement Agreement.

21. *Procurement Agreement*—The written instrument, executed by Buyer and Seller, that sets forth the Procurement Contract Price and Procurement Contract Times, identifies the parties and the Engineer, and designates the specific items that are Procurement Contract Documents.

22. *Procurement Bidding Documents*—The Procurement Bidding Requirements and the proposed Procurement Contract Documents (including all Addenda).

23. *Procurement Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and Bid Form with any supplements.

24. *Procurement Contract*—The entire and integrated written agreement between Buyer and Seller concerning the Goods and Special Services.

25. *Procurement Contract Documents*—Those items so designated in the Procurement Agreement, and which together comprise the Procurement Contract. Shop Drawings and other Seller submittals are not Procurement Contract Documents, even if accepted, reviewed, or approved by Engineer or Buyer.

26. *Procurement Contract Price*—The money that Buyer has agreed to pay Seller for furnishing the Goods and Special Services in accordance with the Procurement Contract Documents.

27. *Procurement Contract Times*—The times stated in the Procurement Agreement by which the Goods must be delivered, Special Services must be furnished, and other Milestones must be attained.

28. *Procurement Drawings*—That part of the Procurement Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Goods and Special Services to be furnished by Seller. Shop Drawings and other Seller submittals are not Procurement Drawings as so defined.

29. *Procurement Specifications*—That part of the Procurement Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the furnishing of the Goods and Special Services, and certain administrative requirements and procedural matters applicable thereto.

30. *Project*—The total undertaking to be accomplished for Project Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Goods and Special Services are a part.

31. *Project Owner*—The entity that has retained (or will retain) engineers, contractors, and others for the planning, study, design, construction, testing, commissioning, and start-up of facilities and improvements. As of the Effective Date of the Procurement Contract, the Project Owner is the Buyer.

32. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Goods and Special Services and which establish the standards by which such portion of the Goods and Special Services will be judged.

33. *Schedule of Submittals*—A schedule, prepared and maintained by Seller, of required Submittals and the time requirements for Engineer's review of the Submittals.

34. *Seller*—The individual or entity furnishing the Goods and Special Services.

35. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Seller and submitted by Seller to illustrate some portion of the Goods and Special Services. Shop Drawings, whether approved or not, are not Procurement Drawings and are not Procurement Contract Documents.

36. *Special Services*—Services to be performed by Seller (or its agents or subcontractors) in association with the Goods to be furnished by Seller, as required by the Procurement Contract Documents.

37. *Submittal*—A written or graphic document, prepared by or for Seller, which the Procurement Contract Documents require Seller to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals

may include Shop Drawings and Samples; schedules; product data; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or site quality-control testing and inspections; warranties and certifications; suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; record documents; and other such documents required by the Procurement Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Procurement Contract Documents. Change proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.

38. *Successful Bidder*—The Bidder whose Bid the Buyer accepts, and to which Buyer makes an award of the Procurement Contract.

39. *Supplementary Conditions*—The part of the Procurement Contract that amends or supplements these General Conditions.

40. *Unit Price Goods and Special Services*—Goods and Special Services to be paid for on the basis of unit prices (if any).

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B and 1.02.C are not defined, but have the indicated meanings when used in the Bidding Requirements or Procurement Contract Documents.

B. *Intent of Certain Terms or Adjectives*

1. The Procurement Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Goods and Special Services. It is intended that such exercise of professional judgment, action, or determination will be commercially reasonable and will be solely to evaluate, in general, the Goods and Special Services for compliance with the requirements of and information in the Procurement Contract Documents and conformance with the design concept of the completed Project as a functioning whole, as shown or indicated in the Procurement Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective will not be effective to assign to Engineer any duty or authority to supervise or direct the furnishing of Goods or Special Services or any duty or authority to undertake responsibility contrary to any other provision of the Procurement Contract Documents.

2. The word "non-conforming" when modifying the words "Goods and Special Services," "Goods," or "Special Services," refers to Goods and Special Services that are unsatisfactory, faulty, or deficient in that they:

a. do not conform to or comply with the requirements of the Procurement Contract Documents;

b. do not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Procurement Contract Documents; or

c. in the case of Special Services, have not been completed.

3. The word “receipt” when referring to the Goods, means the physical taking and possession by the Buyer under the conditions specified in Paragraph 9.02.B.2.

4. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

5. The word "furnish," when used in connection with the Goods and Special Services means to supply and deliver said Goods to the Point of Destination (or some other specified location) and to perform said Special Services fully, all in accordance with the Procurement Contract Documents.

C. *Procurement Contract Price or Procurement Contract Times*: References to a change in “Procurement Contract Price or Procurement Contract Times” or “Procurement Contract Times or Procurement Contract Price” or similar, indicate that such change applies to (1) Procurement Contract Price, (2) Procurement Contract Times, or (3) both Procurement Contract Price and Procurement Contract Times, as warranted, even if the term “or both” is not expressed.

D. Unless stated otherwise in the Procurement Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Procurement Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

A. When Seller delivers the executed counterparts of the Procurement Agreement to Buyer, the Seller also shall deliver to Buyer the performance bond and payment bond (if the Procurement Contract requires Seller to furnish such bonds).

B. *Evidence of Seller’s Insurance*: When Seller delivers the signed counterparts of the Procurement Agreement to Buyer, the Seller also shall deliver to Buyer, with copies to each additional insured (as identified in the Procurement Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Seller in accordance with Article 5. Evidence of insurance to be obtained at a later date, such as insurance relating to transit or storage of the Goods, will be provided to Buyer at the time of such insurance is obtained.

C. *Evidence of Buyer’s Insurance*: After receipt of the signed counterparts of the Procurement Agreement and all required bonds and insurance documentation, Buyer shall promptly deliver to Seller, with copies to each additional insured (as identified in the Procurement Contract), certificates and other evidence of insurance (if any) required to be provided by Buyer.

2.02 *Copies of Documents*

A. Buyer shall furnish to Seller four printed copies of the Procurement Contract (including one fully executed counterpart of the Procurement Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

2.03 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Procurement Contract, the Buyer, Seller, and Engineer may send, and shall accept, Electronic Documents transmitted by Electronic Means.

B. If the Procurement Contract does not establish protocols for Electronic Means, then Buyer, Seller, and Engineer shall jointly develop such protocols.

C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

2.04 *Preliminary Schedules*

A. Within 15 days after the Effective Date of the Procurement Contract, Seller shall submit to Buyer and Engineer for timely review:

1. a progress schedule of activities, consistent with the Procurement Contract Times, including at a minimum, Shop Drawing and Sample submittals, tests, and deliveries as required by the Procurement Contract Documents.

a. The progress schedule will be acceptable to Buyer and Engineer if it provides an orderly progression of the Submittals, tests, and deliveries to completion within the specified Milestones of the Procurement Contract Times.

b. Such acceptance will not impose on Buyer or Engineer responsibility for the progress schedule, for sequencing, scheduling, or progress of Seller's performance of its obligations under the Procurement Contract, nor interfere with or relieve Seller from Seller's full responsibility therefor.

c. Such acceptance will not be deemed as an acknowledgment of the reasonableness and attainability of the schedule.

2. a preliminary schedule of Submittals.

B. No progress payment will be made to Seller until an acceptable progress schedule and acceptable schedule of Submittals are submitted to Buyer and Engineer (and other conditions applicable to progress payments are met).

2.05 *Preliminary Conference*

A. Within 20 days after the Procurement Contract Times start to run, a conference attended by Seller, Buyer, Engineer and others as appropriate will be held to establish a working understanding among the parties as to the Goods and Special Services and to discuss the schedules referred to in Paragraph 2.04.A, procedures for handling Shop Drawings and other Submittals, processing Applications for Payment, and maintaining required records.

2.06 *Safety*

A. Buyer and Seller shall comply with all applicable Laws and Regulations relating to the safety of persons or property, and to the protection of persons or property from damage, injury, or loss.

B. When Seller's personnel, or the personnel of any subcontractor to Seller, are present at the Point of Destination or any work area or site controlled by Buyer, the Seller shall be responsible for the compliance by such personnel with any applicable requirements of Buyer's safety programs that are made known to Seller.

C. If Buyer or its representatives visit the Seller's manufacturing or storage facilities, for testing, inspection, or other purposes, Seller shall inform Buyer in advance of any safety preparations, standards, or programs with which Buyer and its representatives must comply.

ARTICLE 3—PROCUREMENT CONTRACT DOCUMENTS

3.01 *Intent*

A. The Procurement Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Procurement Contract Documents or from prevailing custom or trade usage as being required to produce or furnish the indicated Goods and Special Services will be provided, whether or not specifically called for, at no additional cost to Buyer.

C. Unless otherwise stated in the Procurement Contract Documents, if there is a discrepancy between the electronic or digital versions of the Procurement Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version will govern.

D. The Procurement Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

E. Engineer will issue clarifications and interpretations of the Procurement Contract Documents, as provided in Paragraph 3.04.

F. Any provision or part of the Procurement Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Buyer and Seller.

3.02 *Reference Standards*

A. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws and Regulations, whether such reference be specific or by implication, means the standard, specification, manual, code, or Laws and Regulations in effect at the time of opening of Bids (or on the Effective Date of the Procurement Agreement if there were no Bids), except as may be otherwise specifically stated in the Procurement Contract Documents.

B. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a supplier, will be effective to change the duties or responsibilities of Buyer, Seller, or Engineer from those set forth in the part of the Procurement Contract Documents prepared by or for Engineer. No such provision or instruction will be effective to assign to Buyer or Engineer any duty or authority to supervise or direct the performance of Seller's obligations, or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Procurement Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Seller's Review of Procurement Contract Documents*: If, before or during the performance of Seller's obligations, Seller discovers any conflict, error, ambiguity, or discrepancy within the Procurement Contract Documents, or between the Procurement Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any supplier to Seller, then Seller shall promptly report it to Engineer (or if the Procurement Contract is assigned, then directly to Contractor/Assignee) in writing. Seller shall not proceed with the Goods and Special Services affected thereby until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer (or if the Procurement Contract is assigned, then by Contractor/Assignee) or by an amendment or supplement to the Procurement Contract Documents issued pursuant to Article 11.

2. Seller shall not be liable to Buyer or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Procurement Contract Documents unless Seller had actual knowledge thereof.

B. *Resolving Discrepancies*: Except as may be otherwise specifically stated in the Procurement Contract Documents, the provisions of the Procurement Contract Documents will take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Procurement Contract Documents and:

1. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Procurement Contract Documents); or

2. the provisions of any Laws or Regulations applicable to the furnishing of the Goods and Special Services (unless such an interpretation of the provisions of the Procurement Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Procurement Drawings and Procurement Specifications*

A. During the performance of Seller's obligations and until final payment, Seller and Buyer shall submit to the Engineer all matters in question concerning the requirements of the Procurement Drawings and Procurement Specifications (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Goods and Special Services, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Procurement Drawings and Procurement Specifications, and judge of the acceptability of the Goods and Special Services thereunder.

1. After assignment (if any) Seller shall submit such matters directly to Contractor/Assignee for response or administration, and the Procurement Contract provisions in Paragraphs 3.04.B and C will not apply.

B. Engineer will issue with reasonable promptness a written clarification, interpretation, or decision on the issue submitted, and if necessary, initiate an amendment or supplement to the Procurement Drawings or Procurement Specifications. Engineer's written clarification, interpretation, or decision will be consistent with the overall intent of the Procurement Contract Documents, and will be final and binding on Seller and Buyer. If either Buyer or Seller believes that a written clarification or interpretation justifies an adjustment in the

Procurement Contract Price or Procurement Contract Times, either may make a Claim for such adjustment as provided in Article 12.

C. If a submitted matter in question concerns terms and conditions of the Procurement Contract Documents that do not involve (1) the performance or acceptability of the Goods and Services, (2) the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Buyer and Seller that Engineer is unable to provide a decision or interpretation.

3.05 *Reuse of Documents*

A. Seller and its subcontractors and suppliers shall not:

1. have or acquire any title to or ownership rights in any of the Procurement Drawings, Procurement Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions, or reuse any such Procurement Drawings, Procurement Specifications, other documents, or copies thereof, on extensions of the Project or any other project, without written consent of Buyer and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Procurement Contract Documents, reuse any such Procurement Contract Documents for any purpose without Buyer's express written consent, or violate any copyrights pertaining to such Procurement Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Procurement Contract. Nothing herein precludes Seller from retaining copies of the Procurement Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND SCHEDULE

4.01 *Commencement of Procurement Contract Times*

A. The Procurement Contract Times will commence to run on the Effective Date of the Procurement Contract.

4.02 *Continuing Performance*

A. Seller shall adhere to the progress schedule established in accordance with Paragraph 2.04.A., as duly adjusted, and the Goods will be delivered and the Special Services furnished within the Procurement Contract Times.

B. Seller shall carry on furnishing of the Goods and Special Services and adhere to the progress schedule during all disputes or disagreements with Buyer. No furnishing of Goods and Special Services will be delayed or postponed pending resolution of any disputes or disagreements, except as expressly permitted herein, or as Buyer and Seller may otherwise agree in writing.

4.03 *Adjustments to Progress Schedule*

A. The progress schedule established in accordance with Paragraph 2.04 may be adjusted from time to time as provided below.

1. Seller shall submit to Buyer for acceptance (to the extent indicated in Paragraph 2.04) proposed adjustments in the progress schedule that will not result in changing the Procurement Contract Times. Such adjustments will comply with any applicable provisions of the Procurement Specifications.

2. Proposed adjustments in the progress schedule that will change the Procurement Contract Times must be submitted in accordance with the requirements of Article 11. Adjustments in Procurement Contract Times may only be made by a Change Order.

4.04 *Delays*

A. If Buyer, Engineer, or anyone for whom Buyer is responsible, delays, disrupts, or interferes with Seller's performance or progress, then Seller shall be entitled to an equitable adjustment in Procurement Contract Price or Procurement Contract Times.

B. Seller shall not be entitled to an adjustment in Procurement Contract Price or Procurement Contract Times for delay, disruption, or interference caused by or within the control of Seller or anyone for whom Seller is responsible.

C. If Seller's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Buyer, Seller, and those for which they are responsible, then Seller shall be entitled to an equitable adjustment in Procurement Contract Times. Such an adjustment will be Seller's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Procurement Contract Times under this paragraph include but are not limited to the following:

1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;

2. abnormal weather conditions;

3. inspection delays by governmental authorities, and custom delays;

4. international shipping delays;

5. acts or failures to act of third-party entities; and

6. acts of war or terrorism.

D. *Adjustments of Procurement Contract Times or Procurement Contract Price—General Provisions*: Seller's entitlement to an adjustment of Procurement Contract Times or Procurement Contract Price is limited as follows:

1. Seller's entitlement to an adjustment of the Procurement Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of Seller's obligations, as of the time of the delay, disruption, or interference.

2. Seller shall not be entitled to an adjustment in Procurement Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Seller. Such a concurrent delay by Seller does not preclude an adjustment of Procurement Contract Times to which Seller is otherwise entitled.

3. Adjustments of Procurement Contract Times or Procurement Contract Price are subject to the provisions of Articles 11 and 12.

E. Each Seller request seeking a delay-related increase in Procurement Contract Times or Procurement Contract Price must be supplemented by supporting data that sets forth in detail the following: (1) the circumstances that form the basis for the requested adjustment; (2) the date upon which each cause of delay, disruption, or interference began to affect Seller's progress; (3) the date upon which each cause of delay, disruption, or interference ceased to affect Seller's progress; (4) the number of days' increase in Procurement Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and (5) the impact on Procurement Contract Price. Seller shall also furnish such additional supporting documentation as Buyer or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion.

ARTICLE 5—BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

A. Seller shall furnish a performance bond and a payment bond, each in an amount at least equal to the Procurement Contract Price, as security for the faithful performance and payment of Seller's obligations under the Procurement Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 9.04, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Procurement Contract.

B. Seller shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Procurement Contract.

C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Buyer prior to execution of the Procurement Contract, except as provided otherwise by Laws or Regulations, and must be issued and signed by a surety named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

D. Seller shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.

E. If the surety on a bond furnished by Seller is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Seller shall promptly notify Buyer and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements of this Procurement Contract.

F. If Seller has failed to obtain a required bond, Buyer may exercise Buyer's termination rights under Article 14.

G. Upon request to Buyer from any subcontractor, supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of Seller's obligations, Buyer shall provide a copy of the payment bond to such person or entity.

H. Upon request to Seller from any subcontractor, supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of Seller's obligations, Seller shall provide a copy of the payment bond to such person or entity.

5.02 *Insurance*

A. Seller shall provide insurance of the types and coverages and in the amounts stipulated in the Supplementary Conditions.

B. Failure of Buyer to demand certificates of insurance or other evidence of Seller's full compliance with these insurance requirements or failure of Buyer to identify a deficiency in compliance from the evidence provided will not be construed as a waiver of Seller's obligation to maintain such insurance.

C. Upon assignment of this Procurement Contract, Seller shall name the Contractor/Assignee as an additional insured and comply with the written request of Contractor/Assignee to provide evidence of insurance.

D. Buyer does not represent that insurance coverage and limits established in this Procurement Contract necessarily will be adequate to protect Seller.

E. The insurance and insurance limits required herein will not be deemed as a limitation on Seller's liability under the indemnities and other rights granted to Buyer in the Procurement Contract.

5.03 *Surety or Insurance Companies*

A. All bonds and insurance required by the Procurement Contract Documents to be purchased and maintained by Buyer or Seller shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies must also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

ARTICLE 6—LICENSES AND FEES

6.01 *Intellectual Property and License Fees*

A. Except to the extent stated elsewhere in the Procurement Contract Documents, Seller is not transferring any patent rights, copyrights, or other intellectual property rights for the Goods delivered.

B. To the extent Seller is manufacturing to Buyer's design, Buyer retains all patent rights, copyrights, and other intellectual property rights in such design.

C. If an invention, design, process, product, or device is specified in the Procurement Contract Documents for incorporation in the Goods or for the performance of Special Services, and if, to the actual knowledge of Buyer or Engineer, its use is subject to patent rights, copyrights,

or other intellectual property rights calling for the payment of a license fee or royalty to others, then the existence of such rights and payment obligations will be disclosed to Seller in the Procurement Contract Documents.

D. Seller shall pay all license fees and royalties and assume all costs incident to the use or the furnishing of the Goods, unless specified otherwise by the Procurement Contract Documents.

6.02 *Seller's Infringement*

A. Subject to Paragraph 6.01, to the fullest extent permitted by Laws and Regulations, Seller shall indemnify and hold harmless Buyer, Engineer, and their officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors, from and against all claims, costs, losses, damages, and judgments (including but not limited to all reasonable fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement or alleged infringement of any patent, copyright, or other intellectual property right by any of the Goods as delivered or Special Services as performed.

B. Buyer will promptly notify Seller in writing of any claim, suit, or threat of suit by a third party for any infringement or alleged infringement of any patent, copyright, or other intellectual property right with respect to the Goods as delivered or Special Services as performed.

C. Seller shall promptly defend or settle the claim or suit. Seller shall have control over such claim or suit, bear all expenses, and satisfy any adverse judgment.

1. If Seller fails to defend such suit or claim after written notice by Buyer, Seller will be bound, in any subsequent suit or claim against Seller by Buyer, by any factual determination in the prior suit or claim.

2. If Buyer fails to provide Seller the opportunity to defend such suit or claim, Buyer shall be barred from any remedy against Seller for such suit or claim.

D. If a determination is made that Seller has infringed upon the intellectual property rights of another, Seller may, at Seller's own expense, obtain the necessary licenses for Buyer's benefit, or replace the Goods and provide related design and construction, consistent with the requirements of the Procurement Contract Documents, to avoid the infringement.

6.03 *Buyer's Infringement*

A. Subject to Paragraph 6.01, and to the fullest extent permitted by Laws and Regulations, Buyer shall be responsible to Seller for any infringement or alleged infringement of any patent, copyright, or other intellectual property right caused by Seller's compliance with the Procurement Drawings or Procurement Specifications, and will reimburse Seller for any license fee or royalties paid by Seller to others if such payment resulted from any invention, design, process, product, or device specified to be furnished or performed in the Procurement Drawings or Procurement Specifications, but not identified as being subject to payment of such license fee or royalty.

B. Seller will promptly notify Buyer in writing of any claim, suit, or threat of suit by a third party for intellectual property infringement arising from Seller's compliance with the Procurement Drawings or Procurement Specifications.

C. Buyer shall defend or settle the claim or suit. Buyer shall have control over such claim or suit, bear all expenses, and satisfy any adverse judgment.

1. If Buyer fails to defend such suit or claim after written notice by Seller, Buyer will be bound, in any subsequent suit or claim against Buyer by Seller, by any factual determination in the prior suit or claim.

2. If Seller fails to provide Buyer the opportunity to defend such suit or claim, Seller shall be barred from any remedy against Buyer for such suit or claim.

ARTICLE 7—SELLER'S RESPONSIBILITIES

7.01 *Performance of Obligations*

A. Seller shall be solely responsible for the means, methods, techniques, sequences, and procedures necessary to perform its obligations in accordance with the Procurement Contract Documents.

B. Seller shall supervise, inspect, and direct the furnishing of the Goods and Special Services competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform its obligations in accordance with the Procurement Contract Documents.

C. Seller shall coordinate the provision of Special Services to avoid or limit interference or disruption of other activities at the location where the Special Services are to occur, including but not limited to ongoing facility operations and construction activities.

7.02 *Labor, Materials and Equipment*

A. Seller shall provide competent, qualified and trained personnel in all aspects of its performance of the Procurement Contract.

B. All Goods, and all equipment and material incorporated into the Goods, must be as specified, and unless specified otherwise in the Procurement Contract Documents, must be:

1. new, and of good quality;

2. protected, assembled, connected, cleaned, and conditioned in accordance with the original manufacturer's instructions; and

3. shop-assembled to the greatest extent practicable.

7.03 *Laws and Regulations*

A. Seller shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of its obligations in accordance with the Procurement Contract Documents. Except where otherwise expressly required by such Laws and Regulations, neither Buyer nor Engineer shall be responsible for monitoring Seller's compliance with any Laws or Regulations.

B. If Seller furnishes Goods and Special Services knowing or having reason to know that such furnishing is contrary to Laws or Regulations, Seller shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such performance. It will not be Seller's responsibility to make certain

that the Procurement Specifications and Procurement Drawings are in accordance with Laws and Regulations, but this provision will not relieve Seller of Seller's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Procurement Contract if there were no Bids) that have a direct effect on the cost or time of Seller's performance will be the subject of an adjustment in Procurement Contract Price or Procurement Contract Times. If Buyer and Seller are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Article 12.

7.04 *"Or Equals"*

A. Whenever an item of material or equipment to be incorporated into the Goods is specified or described in the Procurement Contract Documents by using the names of one or more proprietary items or specific suppliers or manufacturers, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, other items of material or equipment or material or equipment of other suppliers or manufacturers may be submitted to Buyer for Engineer's review.

1. If in Engineer's sole discretion, such an item of material or equipment proposed by Seller is functionally equal to that named and sufficiently similar so that no change in related work will be required, it may be considered by Engineer as an "or equal" item.

2. For the purposes of this paragraph, a proposed item of material or equipment may be considered functionally equal to an item so named only if in the exercise of reasonable judgment, Engineer determines that: 1) it is at least equal in quality, durability, appearance, strength, and design characteristics; 2) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole; 3) it has an acceptable record of performance and availability of responsive service; and (4) Seller certifies that if approved: a) there will be no increase in any cost, including capital, installation or operating costs, to Buyer; and b) the proposed item will conform substantially to the detailed requirements of the item named in the Procurement Contract Documents.

B. *Engineer's Evaluation*: Engineer will be allowed a reasonable time within which to evaluate each proposal or Submittal made pursuant to Paragraph 7.04.A. Engineer will be the sole judge of whether to accept or reject such a proposal or Submittal. No "or equal" will be ordered, manufactured or utilized until Engineer's review is complete, which will be evidenced by an approved Shop Drawing. Engineer will advise Buyer and Seller in writing of any negative determination. Notwithstanding Engineer's approval of an "or-equal" item, Seller shall remain obligated to comply with the requirements of the Procurement Contract Documents.

C. *Special Guarantee*: Buyer may require Seller to furnish at Seller's expense a special performance guarantee or other surety with respect to any such proposed "or-equal."

D. *Data*: Seller shall provide all data in support of any such proposed "or equal" at Seller's expense.

7.05 *Taxes*

A. Seller shall pay all taxes and duties arising out of the sale of the Goods and the performance of Special Services. All taxes and duties are included in the Procurement Contract Price, except as noted in the Supplementary Conditions.

7.06 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Seller shall:

a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Procurement Contract Documents;

b. determine and verify:

1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal; and

2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of Seller's obligations.

c. confirm that the Submittal is complete with respect to all related data included in the Submittal.

2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Seller has satisfied its obligations under the Procurement Contract Documents with respect to Seller's review of that Submittal, and that Seller approves the Submittal.

3. With each Shop Drawing or Sample, Seller shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Procurement Contract Documents. This notice will be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.

B. *Submittal Procedures for Shop Drawings and Samples*: Seller shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.

1. *Shop Drawings*

a. Seller shall submit the number of copies required in the Procurement Specifications.

b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Seller proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.06.C.

2. *Samples*

a. Seller shall submit the number of Samples required in the Procurement Specifications.

b. Seller shall clearly identify each Sample as to material, supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.06.C.

3. Where a Shop Drawing or Sample is required by the Procurement Contract Documents or the Schedule of Submittals, any related work performed by Seller prior to Engineer's review and approval of the pertinent Submittal will be at the sole expense and responsibility of Seller.

C. *Engineer's Review of Shop Drawings and Samples*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Goods, comply with the requirements of the Procurement Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Procurement Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, manufacturing, fabrication, installation, or shipping, or to safety precautions or programs incident thereto.

3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Seller from responsibility for any variation from the requirements of the Procurement Contract Documents unless Seller has complied with the requirements of Paragraph 7.06.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Procurement Contract Documents in a Field Order or other appropriate Procurement Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Seller from responsibility for complying with the requirements of Paragraphs 7.06.A and B.

6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Procurement Contract Documents, will not, under any circumstances, change the Procurement Contract Times or Procurement Contract Price, unless such changes are included in a Change Order.

7. Neither Engineer's receipt, review, acceptance or approval of a Shop Drawing or Sample will result in such item becoming a Procurement Contract Document.

8. Seller shall furnish Goods that comply with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.06.C.4.

D. *Resubmittal Procedures for Shop Drawings and Samples*

1. Seller shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review

and approval. Seller shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.

2. Seller shall furnish required Shop Drawing and Sample Submittals with sufficient information and accuracy to obtain required approval of an item with no more than two resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Seller shall be responsible for Engineer's charges to Buyer for such time. Buyer may impose a set-off against payments due Seller to secure reimbursement for such charges.

3. If Seller requests a change of a previously approved Shop Drawing or Sample, Seller shall be responsible for Engineer's charges to Buyer for its review time, and Buyer may impose a set-off against payments due Seller to secure reimbursement for such charges, unless the need for such change is beyond the control of Seller.

E. *Submittals Other than Shop Drawings and Samples*

1. The following provisions apply to all Submittals other than Shop Drawings and Samples:

a. Seller shall submit all such Submittals to the Engineer in accordance with the schedule of Submittals and pursuant to the applicable terms of the Procurement Contract Documents.

b. Engineer will provide timely review of all such Submittals in accordance with the schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the schedule of Submittals will be deemed accepted.

c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Procurement Contract Documents as to general form and content of the Submittal.

d. If any such Submittal is not accepted, Seller shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.

2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.04 and 2.05.

7.07 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Seller shall indemnify and hold harmless Buyer, Engineer, Project Owner, and any assignee of Buyer, including Contractor/Assignee, and their officers, directors, members, partners, employees, agents, consultants, contractors, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of Seller's obligations under the Procurement Contract, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Goods themselves), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Seller, or any individual or entity directly or indirectly employed by Seller or anyone for whose acts Seller may be liable.

B. In any and all claims against Buyer, Engineer, Project Owner, or any assignee of Buyer, including Contractor/Assignee, or their officers, directors, members, partners, employees, agents, consultants, contractors, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Seller, any subcontractor, any supplier, or any individual or entity directly or indirectly employed by any of them to furnish any of the Goods and Special Services, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.07.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Seller or any such subcontractor, supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.08 *Concerning Subcontractors and Suppliers*

A. Seller may retain subcontractors and suppliers for the performance of parts of the furnishing of the Goods and Special Services. The Seller's retention of a subcontractor or supplier will not relieve Seller's obligation to Buyer to perform and complete the furnishing the Goods and Special Services in accordance with the Procurement Contract Documents.

ARTICLE 8—SHIPPING AND DELIVERY

8.01 *Shipping*

A. Seller shall select the carrier and bear all costs of packaging, transportation, insurance, special handling, and all other costs associated with shipment and delivery.

8.02 *Delivery*

A. Seller shall deliver the Goods free on board (FOB) to the Point of Destination, freight prepaid, in accordance with the Procurement Contract Times set forth in the Procurement Agreement, or other date agreed to by Buyer and Seller.

B. At least 10 days before shipment, Seller shall provide written notice to Buyer of the manner of shipment and the anticipated delivery date. The notice must also include any instructions concerning special equipment or services required at the Point of Destination to unload and care for the Goods. Seller shall also require the carrier to give Buyer at least 24 hours' notice by telephone prior to the anticipated time of delivery.

C. Buyer will be responsible and bear all costs for unloading the Goods from carrier.

D. Buyer will assure that adequate facilities are available to receive delivery of the Goods at the time established for delivery, or on another date agreed to by Buyer and Seller.

E. No partial deliveries will be allowed, unless permitted or required by the Procurement Contract Documents or agreed to in writing by Buyer.

F. Provisions governing inspection on delivery are set forth in Paragraph 9.02.

8.03 *Risk of Loss*

A. Risk of loss and insurable interests transfer from Seller to Buyer upon Buyer's receipt of the Goods.

B. Notwithstanding the provisions of Paragraph 8.03.A, if Buyer rejects the Goods as non-conforming, the risk of loss on such Goods will remain with Seller until Seller corrects the non-conformity or Buyer accepts the Goods. If rejected Goods remain at the Point of

Destination pending modification and acceptance, then Seller shall be responsible for arranging adequate protection and maintenance of the Goods at Seller's expense.

ARTICLE 9—BUYER'S RIGHTS

9.01 *Seller's Warranties and Guarantees*

A. Seller warrants and guarantees to Buyer that the title to the Goods conveyed will be proper, its transfer rightful, and free from any security interest, lien, or other encumbrance. Seller shall defend, indemnify, and hold Buyer harmless against any liens, claims, or demands contesting or affecting title of the Goods conveyed.

B. Seller warrants and guarantees to Buyer that all Goods and Special Services will conform with the Procurement Contract Documents, and with the standards established by any Samples approved by Engineer. Engineer shall be entitled to rely on Seller's warranty and guarantee. If the Procurement Contract Documents do not otherwise specify the characteristics or the quality of the Goods, the Goods must comply with the requirements of Paragraph 7.02.B.

C. Seller's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, improper modification, improper maintenance, or improper operation by persons other than Seller;

2. excessive corrosion or chemical attack, unless corrosive or chemically-damaging conditions were disclosed by Buyer in the Procurement Contract Documents and the Procurement Contract Documents required the Goods to withstand such conditions;

3. use in a manner contrary to Seller's written instructions for installation, operation, and maintenance; or

4. normal wear and tear under normal usage.

D. Seller's obligation to furnish the Goods and Special Services in accordance with the Procurement Contract Documents will be absolute. None of the following will constitute an acceptance of Goods and Special Services that are non-conforming, or a release of Seller's obligation to furnish the Goods and Special Services in accordance with the Procurement Contract Documents:

1. observations by Buyer, Engineer, or Project Owner;

2. recommendation by Engineer or payment by Buyer of any progress or final payment;

3. use of the Goods by Buyer or Project Owner;

4. any acceptance by Buyer, Engineer, or Project Owner, or any failure to do so;

5. the end of the correction period established in Paragraph 9.04;

6. the issuance of a notice of acceptance;

7. any inspection, test or approval by others; or

8. any correction of non-conforming Goods and Special Services by Buyer or Project Owner.

E. Buyer shall promptly notify Seller of any breach of Seller's warranties or guarantees.

9.02 *Inspections and Testing*

A. *General Provisions*

1. The Procurement Contract Documents specify required inspections and tests. Buyer shall have the right to perform, or cause to be performed, reasonable inspections and require reasonable tests of the Goods at Seller's facility, and at the Point of Destination. Seller shall allow Buyer a reasonable time to perform such inspections or tests.

2. Seller shall reimburse Buyer for all expenses, except for travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, for inspections and tests specified in the Procurement Contract Documents. If as the result of any such specified testing the Goods are determined to be non-conforming, then Seller shall also bear the travel, lodging, and subsistence expenses of Buyer's and Engineer's representatives, and all expenses of re-inspection or retesting.

3. Buyer shall bear all expenses of inspections and tests that are not specified in the Procurement Contract Documents (other than any re-inspection or retesting resulting from a determination of non-conformity, as set forth in Paragraph 9.03); provided, however, that if as the result of any such non-specified inspections or testing the Goods are determined to be non-conforming, then Seller shall bear all expenses of such inspections and testing, and of any necessary re-inspection and retesting.

4. Seller shall provide Buyer timely written notice of the readiness of the Goods for all inspections, tests, or approvals which the Procurement Contract Documents specify are to be observed by Buyer prior to shipment.

5. Buyer will give Seller timely notice of all specified tests, inspections, and approvals of the Goods which are to be conducted at the Point of Destination, and a representative of Seller will attend such tests, inspections, and approvals.

6. If, on the basis of inspections or testing, the Goods appear to be conforming, Buyer will give Seller prompt notice thereof. If on the basis of inspections or testing, the Goods appear to be non-conforming, Buyer will give Seller prompt notice thereof and will advise Seller of the remedy Buyer elects under the provisions of Paragraph 9.03.

7. Neither payments made by Buyer to Seller prior to any tests or inspections, nor any tests or inspections, will constitute acceptance of non-conforming Goods, or prejudice Buyer's rights under the Procurement Contract.

B. *Visual Inspection on Delivery*

1. Buyer will visually inspect the Goods upon delivery solely for purposes of identifying the Goods, general verification of quantities, and observation of apparent condition. Such visual inspection will not be construed as final or as receipt of any Goods and Special Services that, as a result of subsequent inspections and tests, are determined to be non-conforming.

2. If, on the basis of the visual inspection specified in Paragraph 9.02.B.1, the Goods appear to comply with the requirements of the Procurement Contract Documents as to quantities and condition, then within 10 days of delivery Buyer shall issue to Seller Buyer's acknowledgment of the receipt of Goods.

C. *Final Inspection*

1. After all of the Goods have been incorporated into the Project, tested in accordance with such testing requirements as are specified, and are functioning as required, and Seller has performed and completed all Special Services, Buyer will make a final inspection.

2. If, on the basis of the final inspection, Buyer determines that the Goods and Special Services are conforming, Buyer's notice thereof will constitute Buyer's acceptance of the Goods and Special Services, subject to any limitations stated in the notice.

3. If, on the basis of the final inspection, the Goods and Special Services are non-conforming, Buyer will identify the non-conformity in writing.

9.03 *Non-Conforming Goods and Special Services*

A. If, on the basis of inspections and testing prior to delivery, the Goods and Special Services are found to be non-conforming, or if at any time after Buyer has acknowledged receipt of delivery and before the expiration of the correction period described in Paragraph 9.04, Buyer determines that the Goods and Special Services are non-conforming, then Seller shall promptly, without cost to Buyer and in response to written instructions from Buyer, either correct such non-conforming Goods and Special Services, or, if Goods are rejected by Buyer, remove and replace the non-conforming Goods with conforming Goods, including all work required for reinstallation.

B. *Buyer's Rejection of Non-Conforming Goods*

1. If Buyer elects to reject the Goods in whole or in part, Buyer's notice to Seller will describe in sufficient detail the non-conforming aspect of the Goods. If Goods have been delivered to Buyer, Seller shall promptly, and within the Procurement Contract Times, remove and replace the rejected Goods.

2. Seller shall bear all costs, losses and damages attributable to the removal, replacement, reinspection, and retesting of the non-conforming Goods.

3. Upon rejection of the Goods, Buyer retains a security interest in the Goods to the extent of any payments made and expenses incurred in their testing and inspection.

C. *Buyer's Rejection of Non-Conforming Special Services*

1. If at any time Buyer elects to reject the Special Services in whole or in part, Buyer's notice to Seller will describe in sufficient detail the non-conforming aspect of the Special Services.

2. Seller shall promptly provide conforming Special Services acceptable to Buyer.

3. If Seller fails to provide conforming Special Services, Buyer may remove the Special Services from the scope of the Procurement Contract, and equitably reduce the Procurement Contract Price.

D. *Remedying Non-Conforming Goods*: If Buyer elects to permit the Seller to modify the Goods to correct the non-conformance, then Seller shall promptly provide a schedule for such modifications and shall make the Goods conforming within a reasonable time.

E. *Buyer's Acceptance of Non-Conforming Goods*: Instead of requiring correction or removal and replacement of non-conforming Goods discovered either before or after final payment,

Buyer may accept the non-conforming Goods. Seller shall bear all reasonable costs, losses, and damages attributable to Buyer's evaluation of and determination to accept such non-conforming Goods.

F. *Seller Obligations*: Seller shall pay all claims, costs, losses, and damages, including but not limited to all fees and charges for re-inspection, retesting and for any engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs arising out of or relating to the non-conforming Goods and Special Services. Seller's obligations will include the costs of the correction or removal and replacement of the non-conforming Goods and the replacement of property of Buyer and others destroyed by the correction or removal and replacement of the non-conforming Goods, and obtaining conforming Special Services from others.

G. *Buyer's Rejection of Conforming Goods*: If Buyer asserts that Goods and Special Services are non-conforming and such Goods and Special Services are determined to be conforming, or if Buyer rejects as non-conforming Goods and Special Services that are later determined to be conforming, then Seller shall be entitled to reimbursement from Buyer of costs incurred by Seller in inspecting, testing, correcting, removing, or replacing the conforming Goods and Special Services, including but not limited to fees and charges of engineers, architects, attorneys and other professionals, and all court or arbitration or other dispute resolution costs associated with the incorrect assertion of non-conformance or rejection of conforming Goods and Special Services.

9.04 *Correction Period*

A. Seller's responsibility for correcting all non-conformities in the Goods and Special Services will extend for a period of one year after the acceptance of the Goods and Special Services in accordance with Paragraph 9.02.C.2.

B. Where non-conforming Goods and Services (and damage to other work resulting therefrom) have been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Goods and Services will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

C. Seller's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph may not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 10—ENGINEER'S STATUS

10.01 *Engineer's Role Defined*

A. Engineer will be Buyer's representative until assignment (if any) of the Procurement Contract.

B. The duties and responsibilities and the limitations of authority of Engineer prior to assignment, if any, of the Procurement Contract, are set forth in the Procurement Contract Documents.

C. Engineer's responsibilities, if any, after an assignment (if any) of the Procurement Contract, are set forth in the Procurement Agreement.

10.02 *Duties and Responsibilities; Authority; Limitations*

A. As set forth in Article 3, Engineer will be the initial interpreter of the Procurement Contract Documents and judge of the acceptability of the Goods and Special Services, and will issue clarifications, interpretations, and decisions regarding such issues.

B. Acting on behalf of Buyer under the provisions of Article 9, Engineer has the authority to disapprove or reject Goods and Special Services that Engineer believes to be non-conforming. Engineer also has the authority to require special inspection or testing of the Goods or Special Services as provided in Paragraph 9.02, whether or not the Goods are fabricated or installed, or the Special Services are completed.

C. Engineer may authorize minor deviations or variations in the Procurement Contract Documents by: 1) written approval of specific variations set forth in Shop Drawings when Seller has duly noted such variations as required in Paragraph 7.06.A.3, or 2) a Field Order.

D. As set forth in Article 12, Engineer will review Claims, and render decisions on Claims.

E. In rendering any interpretations, clarifications, reviews, decisions, disapprovals, acceptances, rejections, authorizations, and judgments, Engineer will not show partiality to Buyer or Seller. Engineer will not be liable to Buyer, Seller, or others in connection with any interpretations, clarifications, reviews, decisions, disapprovals, acceptances, rejections, authorizations, or judgments conducted or rendered by Engineer in good faith.

F. Engineer will not supervise, direct, control, or have authority over or be responsible for the means, methods, techniques, sequences, or procedures used by Seller to perform its obligations under this Procurement Contract, or the safety precautions and programs incident thereto, or for any failure of Seller to comply with Laws and Regulations applicable to the performance of its obligations. Engineer will not be responsible for Seller's failure to furnish the Goods and Special Services in accordance with the Procurement Contract Documents.

ARTICLE 11—CHANGES

11.01 *Amending and Supplementing the Procurement Contract*

A. The Procurement Contract may be amended or supplemented by a Change Order, a Change Directive, or a Field Order.

B. If an amendment or supplement to the Procurement Contract includes a change in the Procurement Contract Price or the Procurement Contract Times, such amendment or supplement must be set forth in a Change Order.

C. All changes to the Procurement Contract that involve (1) the conformance or acceptability of the Goods and Special Services, (2) the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Buyer and Seller may amend other terms and conditions of the Procurement Contract without the recommendation of the Engineer.

11.02 *Change Orders*

A. Buyer and Seller shall execute appropriate Change Orders covering:

1. Changes in Procurement Contract Price or Procurement Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Goods and Special Services furnished in accordance with a Change Directive;

2. Changes in Procurement Contract Price resulting from a Buyer set-off, unless Seller has duly contested such set-off;

3. Changes in the Goods and Special Services which are: (a) ordered by Buyer pursuant to Paragraph 11.05, (b) required because of Buyer's acceptance of non-conforming Goods and Services under Paragraph 9.03 or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Goods and Special Services involves the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise) or other engineering or technical matters; and

4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Change Directive; Article 12, Claims; and similar provisions.

B. If Buyer or Seller refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Change Directives*

A. A Change Directive will not change the Procurement Contract Price or the Procurement Contract Times but is evidence that the parties expect that the modification ordered or documented by a Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Change Directive's effect, if any, on the Procurement Contract Price and Procurement Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Procurement Contract Documents governing adjustments, expressly including Paragraph 11.08 regarding change of Procurement Contract Price.

B. If Buyer has issued a Change Directive and Buyer or Seller believes that an adjustment in Procurement Contract Times or Procurement Contract Price is necessary, then such party shall submit a Claim seeking such an adjustment no later than 30 days after the completion of the Goods and Services set out in the Change Directive.

11.04 *Field Orders*

A. Engineer may authorize minor changes in the Goods and Services if the changes do not involve an adjustment in the Procurement Contract Price or the Procurement Contract Times and are compatible with the design concept as indicated by the Procurement Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Buyer and also on Seller, which shall perform the Goods and Special Services involved promptly.

B. If Seller believes that a Field Order justifies an adjustment in the Procurement Contract Price or Procurement Contract Times, then before proceeding with the Goods and Special Services at issue, Seller shall submit a Claim as provided herein.

11.05 *Buyer-Authorized Changes in the Goods and Special Services*

A. Without invalidating the Procurement Contract and without notice to any surety, Buyer may, at any time or from time to time, order additions, deletions, or revisions in the Goods and Special Services. Changes involving the design (as set forth in the Procurement Drawings, Procurement Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.

B. Such changes in the Goods and Special Services may be accomplished by a Change Order, if Buyer and Seller have agreed as to the effect, if any, of the changes on Procurement Contract Times or Procurement Contract Price; or by a Change Directive. Upon receipt of any such document, Seller shall promptly proceed with the Goods and Special Services involved; or, in the case of a deletion in the Goods and Special Services, promptly cease activities with respect to such deletion. Added or revised Goods and Special Services must be performed under the applicable conditions of the Procurement Contract Documents.

11.06 *Buyer's Contingency Allowance*

A. The Buyer's Contingency Allowance, if any such is set forth in the Procurement Agreement, is for the sole use of Buyer to cover unanticipated costs.

B. If Buyer exercises its unilateral right to use all or a portion of the Buyer's Contingency Allowance, Buyer will issue a written directive that documents the costs to which the allowance is applied, Seller's entitlement to compensation, and the consequent reduction in such allowance.

C. Prior to final payment, the Total Price, as set forth in the Procurement Agreement, will be duly adjusted to account for any unused portion of the Buyer's Contingency Allowance.

D. The Procurement Agreement, Article 5, addresses the impact on Buyer's Contingency Allowance of an assignment of the Procurement Contract.

11.07 *Unauthorized Changes in the Goods and Special Services*

A. Seller shall not be entitled to an increase in the Procurement Contract Price or an extension of the Procurement Contract Times with respect to any work performed that is not required by the Procurement Contract Documents, as amended, modified, or supplemented.

11.08 *Change of Procurement Contract Price*

A. The Procurement Contract Price may only be changed by a Change Order. Any Claim for an adjustment of Procurement Contract Price must comply with the provisions of Article 12.

B. An adjustment in the Procurement Contract Price will be determined as follows:

1. For changes in Unit Price Goods and Special Services, by application of the unit prices to the quantities of the items involved;

2. To the extent the cost of the change is not covered by unit prices, then by a mutually agreed lump sum; or

3. To the extent the cost of the change is not covered by unit prices and the parties do not reach mutual agreement to a lump sum, then on the basis of documented costs plus a Seller's fee for overhead and profit of 15%.

11.09 *Change of Procurement Contract Times*

A. The Procurement Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Procurement Contract Times must comply with the provisions of Article 12.

11.10 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Goods and Special Services or the provisions of the Procurement Contract (including, but not limited to, Procurement Contract Price or Procurement Contract Times), the giving of any such notice will be Seller's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12—CLAIMS, DISPUTES, AND DISPUTE RESOLUTION

12.01 *Claims*

A. The parties agree to endeavor to avoid or resolve Claims through direct, good faith discussions and negotiations whenever practicable. Such discussions and negotiations should at the outset address whether the parties mutually agree to suspend the Claims process, including the time periods established in this Paragraph 12.01; if so, a written record of such mutual agreement should be made and jointly executed.

B. Claimant shall deliver to Engineer and the other party to the Procurement Contract written notice of each Claim within 15 days after the occurrence of the event giving rise to the Claim.

C. Claimant shall deliver written supporting data to Engineer and the other party within 45 days after such occurrence unless Engineer allows an additional period of time.

D. Engineer will review each such Claim and render a decision in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

E. If Engineer does not render a formal written decision on a Claim within the time stated in Paragraph 12.01.D., Engineer shall be deemed to have issued a decision denying the Claim in its entirety 31 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

F. The rendering of a decision by Engineer pursuant to this Paragraph 12.01 with respect to any such Claim, dispute, or other matter (except any which have been waived by the making or acceptance of final payment) will be a condition precedent to any exercise by Buyer or Seller of such rights or remedies as either may otherwise have under the Procurement Contract Documents or by Laws or Regulations in respect of any such Claim, dispute, or other matter. If the exercise of such rights or remedies will imminently be time-barred, a party may take actions necessary to preserve such rights and remedies notwithstanding the lack of the condition precedent referred to in this paragraph.

G. If a submitted matter in question concerns terms and conditions of the Procurement Contract Documents that do not involve (1) the performance or acceptability of Goods and Special Services under the Procurement Contract Documents, (2) the design (as set forth in the Procurement Drawings, Procurement Specifications, Addenda, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Buyer and Seller that Engineer is unable to provide a decision or interpretation. If Buyer and Seller

are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Paragraph 12.02.

H. Engineer's written decision on such Claim or a decision denying the Claim in its entirety that is deemed to have been issued pursuant to Paragraph 12.01, will be final and binding upon Buyer and Seller 30 days after it is issued unless within 30 days of issuance Buyer or Seller appeals Engineer's decision by initiating the mediation of such Claim in accordance with the dispute resolution procedures set forth in Paragraph 12.02.

I. If Article 12 has been amended to delete the mediation requirement, then Buyer or Seller may appeal Engineer's decision within 30 days of issuance by following the alternative dispute resolution process set forth in Article 12, as amended; or if no such alternative dispute resolution process has been set forth, Buyer or Seller may appeal Engineer's decision by 1) delivering to the other party within 30 days of the date of such decision a written notice of intent to submit the Claim to a court of competent jurisdiction, and 2) within 60 days after the date of such decision instituting a formal proceeding in a court of competent jurisdiction.

J. No Claim for an adjustment in Procurement Contract Price or Procurement Contract Times will be valid if not submitted in accordance with Article 12.

K. The effect on Claims of an assignment of the Procurement Contract by Buyer to a Contractor/Assignee is addressed in the Procurement Agreement, Article 5.

12.02 *Dispute Resolution Method*

A. Either Buyer or Seller may initiate the mediation of (1) any Claim decided in writing by Engineer under Paragraph 12.01 before such decision becomes final and binding, or (2) any other dispute between the parties, including but not limited to any dispute arising after final inspection of the Goods and Services. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Procurement Contract. The request for mediation must be submitted in writing to the American Arbitration Association and the other party to the Procurement Contract. Timely submission of the request will stay Engineer's decision from becoming final and binding.

B. Mediation is a condition precedent to seeking final dispute resolution under Paragraph 12.01.C. Buyer and Seller shall participate in the mediation process in good faith. The process must be concluded within 60 days of filing of the request. The date of termination of the mediation will be determined by application of the mediation rules referenced above.

C. If the mediation process does not result in resolution of the dispute, then Engineer's written Claim decision under Paragraph 12.01.D or a Claim denial pursuant to Paragraph 12.01.E becomes final and binding, or if applicable such other dispute is deemed resolved in favor of respondent, unless, within 30 days after termination of the mediation, Buyer or Seller:

1. elects in writing to invoke any final dispute resolution process provided for in the Supplementary Conditions, or

2. agrees with the other party to submit the Claim or dispute to another final dispute resolution process, or

3. if no final dispute resolution process has been provided for in the Supplementary Conditions, delivers to the other party written notice of the intent to submit the Claim

or dispute to a court of competent jurisdiction, and within 60 days of the termination of the mediation institutes such formal proceeding.

ARTICLE 13—PAYMENT

13.01 *Applications for Progress Payments*

A. Seller shall submit to Buyer for Engineer's review Applications for Payment filled out and signed by Seller and accompanied by such supporting documentation as is required by the Procurement Contract Documents and also as Buyer or Engineer may reasonably require.

B. The timing and amounts of progress payments will be as stipulated in the Procurement Agreement.

C. Any Application for Payment that is based in whole or in part on the delivery of Goods must be accompanied by a bill of sale, invoice, or other documentation reasonably satisfactory to Buyer warranting that Buyer has rightfully received good title to the Goods from Seller and that, upon payment, the Goods will be free and clear of all liens. Such documentation will include releases and waivers from all parties with viable lien rights.

D. Buyer shall notify Seller promptly of any deficiency in the required documentation.

13.02 *Review of Applications for Progress Payments*

A. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Buyer, or return the Application to Seller indicating in writing Engineer's reasons for refusing to recommend payment.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Buyer, based on Engineer's observations of Seller's progress, as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

a. the Goods and Special Services or other obligations of Seller have progressed to the point indicated;

b. the quality of the Goods and Special Services or other obligations of Seller are generally in accordance with the Procurement Contract Documents; and

c. the conditions precedent to Seller being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Seller's progress.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

a. inspections made to check the quality or the quantity of the Goods and Special Services or other obligations of Seller have been exhaustive, extended to every aspect of the Goods and Special Services or other obligations of Seller in progress, or involved detailed inspections of the Goods and Special Services or other

obligations of Seller beyond the responsibilities specifically assigned to Engineer in the Procurement Contract; or

b. there may not be other matters or issues between the parties that might entitle Seller to be paid additionally by Buyer, or entitle Buyer to withhold payment to Seller.

4. Neither Engineer's review of Seller's progress for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

a. to supervise, direct, or control the Seller's performance or furnishing of Goods and Special Services or other obligations of Seller; or

b. for the means, methods, techniques, sequences, or procedures of construction, manufacturing, fabrication, installation, or shipping, or the safety precautions and programs incident thereto; or

c. for Seller's failure to comply with Laws and Regulations applicable to Seller's performance under the Procurement Contract; or

d. to make any examination to ascertain how or for what purposes Seller has used the money paid for the Procurement Contract Price; or

e. to determine that title to any of the Goods or component parts have passed to Buyer free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Buyer stated in Paragraph 13.02.A.2.

6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Buyer from loss because:

a. the Goods and Services are non-conforming, requiring correction or replacement;

b. the Procurement Contract Price has been reduced by Change Orders;

c. Buyer has been required to correct non-conforming Goods and Special Services in accordance with Paragraph 9.03.C, or has accepted non-conforming Goods and Special Services pursuant to Paragraph 9.03.E; or

d. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Seller and therefore justify termination for cause under the Procurement Contract Documents.

13.03 *Basis and Amount of Progress Payments*

A. The basis and amounts of the progress payments will be as provided in the Procurement Agreement, subject to the provisions of this Article 13 regarding reductions in payment.

13.04 *Suspension of or Reduction in Payment*

A. Buyer may temporarily cease making progress payments, or reduce the amount of a progress payment, even though recommended for payment by Engineer, under the following circumstances:

1. Buyer has reasonable grounds to conclude that Seller will not furnish the Goods or the Special Services in accordance with the Procurement Contract Documents, and

2. Buyer has requested in writing assurances from Seller that the Goods and Special Services will be delivered or furnished in accordance with the Procurement Contract Documents, and Seller has failed to provide adequate assurances within ten days of Buyer's written request.

3. In addition to any reductions in payment (set-offs) recommended by Engineer, Buyer is entitled to impose a set-off against payment based on any of the following:

    a. claims have been made against Buyer based on Seller's conduct in the performance or furnishing of the Goods and Special Services, or has incurred costs, losses, or damages resulting from Seller's conduct in the performance or furnishing of the Goods and Special Services, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

    b. Seller has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Point of Destination or the worksite;

    c. Seller has failed to provide and maintain required bonds or insurance;

    d. Buyer has incurred extra charges or engineering costs related to Submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;

    e. the Goods and Special Services are non-conforming, requiring correction or replacement;

    f. Buyer has been required to correct non-conforming Goods and Special Services, in accordance with Paragraph 9.03.C, or has accepted non-conforming Goods and Special Services pursuant to Paragraph 9.03.E;

    g. the Procurement Contract Price has been reduced by Change Orders;

    h. an event that would constitute a default by Seller and therefore justify a termination for cause has occurred;

    i. liquidated or other damages have accrued as a result of Seller's failure to achieve Milestones, Substantial Completion, or final completion of the Goods and Special Services; or

    j. liens have been filed in connection with the Procurement Contract, except where Seller has delivered a specific bond satisfactory to Buyer to secure the satisfaction and discharge of such liens.

B. If Buyer refuses to make payment of the full amount recommended by Engineer, Buyer will provide Seller and Engineer immediate written notice stating the reason for such action and promptly pay Seller any amount remaining after deduction of the amount withheld. Buyer shall promptly pay Seller the amount withheld when Seller corrects the reason for such action to Buyer's satisfaction.

13.05 *Final Payment*

A. After Seller has corrected all non-conformities to the reasonable satisfaction of Buyer and Engineer and furnished all Special Services, Seller may submit its final Application for Payment following the procedures for progress payments.

B. The final Application for Payment will be accompanied by all documentation called for in the Procurement Contract Documents (including but not limited to all final operations and maintenance manuals, and any special warranties), a list of all unsettled Claims, and the written consent of surety to the making of final payment.

C. If, on the basis of final inspection and the review of the final Application for Payment and accompanying documentation, Engineer is reasonably satisfied that Seller has furnished the Goods and Special Services in accordance with the Procurement Contract Documents, and that Seller has fulfilled all other obligations under the Procurement Contract Documents, then Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment subject to the provisions of Paragraph 13.02, and present the final Application for Payment to Buyer. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Buyer from loss for the reasons stated in Paragraph 13.02.

D. If Engineer does not recommend final payment, Engineer will return the final Application for Payment to Seller, indicating the reasons for refusing to recommend final payment, in which case Seller shall make the necessary corrections and resubmit the final Application for Payment.

E. In support of its recommendation of final payment Engineer will also give written notice to Buyer and Seller that the Goods and Special Services are acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 13.06.

F. If the final Application for Payment and accompanying documentation are appropriate as to form and substance, Buyer shall, within 30 days after receipt thereof, pay Seller the amount recommended by Engineer, less any sum Buyer is entitled to set off against Engineer's recommendation, pursuant to the provisions of Paragraph 13.04.

G. Buyer will not make final payment, or return or release included retainage (if any) at any time, unless Seller submits written consent of the surety to such payment, return, or release.

13.06 *Waiver of Claims*

A. By making final payment, Buyer waives its claim or right to liquidated damages or other damages for late completion by Seller, except as set forth in an outstanding Claim, appeal, set-off, or express reservation of rights by Buyer. Buyer reserves all other claims or rights after final payment.

B. The acceptance of final payment by Seller will constitute a waiver by Seller of all claims and rights against Buyer other than those pending matters that have been duly submitted or appealed under the provisions of Article 12.

ARTICLE 14—CANCELLATION, SUSPENSION, AND TERMINATION

14.01 *Cancellation*

A. Buyer has the right to cancel the Procurement Contract, without cause, at any time prior to delivery of the Goods by written notice. Cancellation pursuant to the terms of this paragraph will not constitute a breach of contract by Buyer. Upon cancellation:

1. Buyer shall pay Seller for the direct costs incurred in producing any Goods that Seller has specially manufactured for the Project, plus a fair and reasonable amount for overhead and profit.

2. For Goods that are not specially manufactured for the Project, Seller shall be entitled to a restocking charge of 10 percent of the unpaid Procurement Contract Price of such Goods.

14.02 *Suspension of Performance by Buyer*

A. Buyer has the right to suspend performance of the Procurement Contract for up to 90 days, without cause, by written notice. Upon suspension under this paragraph, Seller shall be entitled to an increase in the Procurement Contract Times and Procurement Contract Price caused by the suspension, provided that performance would not have been suspended or delayed for causes attributable to Seller.

14.03 *Suspension of Performance by Seller*

A. Seller may suspend the furnishing of the Goods and Special Services only under the following circumstance:

1. Seller has reasonable grounds to conclude that Buyer will not perform its future payment obligations under the Procurement Contract; and

2. Seller has requested in writing assurances from Buyer that future payments will be made in accordance with the Procurement Contract, and Buyer has failed to provide such assurances within ten days of Seller's written request.

14.04 *Breach and Termination*

A. *Buyer's Breach*

1. Seller shall have the right to terminate the Procurement Contract for cause by declaring a breach if Buyer fails to comply with any material provision of the Procurement Contract. Upon termination, Seller shall be entitled to all remedies provided by Laws and Regulations.

2. If Seller believes Buyer is in breach of its obligations under the Procurement Contract, Seller shall provide Buyer with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Buyer shall have 7 days from receipt of the written notice declaring the breach (or such longer period of time as Seller may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

B. *Seller's Breach*

1. Buyer may terminate Seller's right to perform the Procurement Contract for cause by declaring a breach should Seller fail to comply with any material provision of the

Procurement Contract Documents. Upon termination, Buyer shall be entitled to all remedies provided by Laws and Regulations.

2. In the event Buyer believes Seller is in breach of its obligations under the Procurement Contract, Buyer shall provide Seller with reasonably prompt written notice setting forth in sufficient detail the reasons for declaring that it believes a breach has occurred. Seller shall have 7 days from receipt of the written notice declaring the breach (or such longer period of time as Buyer may grant in writing) within which to cure or to proceed diligently to cure such alleged breach.

3. If and to the extent that Seller has provided a performance bond under the provisions of Paragraph 5.01, the notice and cure procedures of that bond, if any, will supersede the notice and cure procedures of Paragraph 14.04.B.2.

ARTICLE 15—MISCELLANEOUS

15.01 *Giving Notice*

A. Whenever any provision of the Procurement Contract requires the giving of written notice to Buyer, Seller, or Engineer, it will be deemed to have been validly given if delivered:

1. in person, by a commercial courier service or otherwise, to the recipient's place of business;

2. by registered or certified mail, postage prepaid, to the recipient's place of business; or

3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

15.02 *Controlling Law*

A. This Procurement Contract is to be governed by the law of the state in which the Goods are to be installed.

B. In the case of any conflict between the express terms of this Procurement Contract and the Uniform Commercial Code, as adopted in the state whose law governs, it is the intent of the parties that the express terms of this Procurement Contract will apply.

15.03 *Computation of Time*

A. When any period of time is referred to in the Procurement Contract by number of days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

15.04 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Procurement Contract, and the provisions of this paragraph will be as effective as if repeated specifically in the Procurement Contract in connection with each particular duty, obligation, right, and remedy to which they apply.

15.05 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Procurement Contract, as well as all continuing obligations indicated in the Procurement Contract, will survive final payment, completion, and acceptance of the Goods and Special Services or termination or completion of the Procurement Contract or of the services of Seller.

15.06 *Entire Agreement*

A. Buyer and Seller agree that this Procurement Contract is the complete and final agreement between them, and supersedes all prior negotiations, representations, or agreements, either written or oral. This Procurement Contract may not be altered, modified, or amended except in writing signed by an authorized representative of both parties.

15.07 *No Waiver*

A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Procurement Contract.

15.08 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

15.09 *Successors and Assigns*

A. Buyer and Seller each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Procurement Contract.

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SECTION 01 1100

SUMMARY OF WORK

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 PROJECT DESCRIPTION

A. This project consists of the procurement of membrane softening equipment for two (2) water treatment plants in Warren County Ohio—the Richard A. Renneker WTP (RARWTP) and the Franklin Area WTP (FAWTP).
   1. The RARWTP membrane softening addition is designed to treat 13.7 MGD (expandable to 22.0 MGD) of groundwater. Equipment includes six (6) nanofiltration membrane softening skids and all associated controls and appurentences as identified on the drawings and the specifications.
   2. The FAWTP membrane softening addition is designed to treat 9.6 MGD (expandable to 15 MGD) of groundwater. Equipment includes three (3) nanofiltration membrane softening skids and all associated controls and appurentences as identified on the drawings and the specifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 1100

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SECTION 01 3300

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 GENERAL

A. All submittals shall be made to the Engineer unless specifically noted otherwise or unless instructed in writing by the Owner.

B. Submit a complete list of required submittals.

C. Receive, check, approve as required, and submit all items listed herein by the time indicated, accompanied by a transmittal letter using the form attached at the end of this Section.

D. Keep an accurate record of the date of submittal and the date received on the Project.

E. Contractor shall supply all AIA forms. (One source of supply is the local AIA Chapter office.) The Engineer will supply a copy of all other forms.

F. Following is a general list of required submittals and the time frame for submittal.
   1. Within 30 Days after Contract Signing
      a. Progress schedule.
      b. Submittal schedule.
   2. Prior to First Progress Payment
      a. Progress Schedule.
      b. Submittal Schedule.
      c. Application and Certificate for Payment.
      d. Schedule of Values.
      e. Subcontractor and Material Lists.
   3. With Each Progress Payment.
      a. Affidavit and Waiver of Lien (see attached form) from each Contractor and sub-contractor.
      b. Submittal Schedule.
      c. Schedule of Values.
   4. As Work Progresses
      a. Monthly updated Progress Schedule.
      b. Wage Rate and Payroll Certificates.
      c. Notice of Furnishings.
      d. Materials Certifications.
      e. Test Reports.
      f. Shop Drawings.
      g. Maintenance Instructions.
      h. Operating Instructions.
      i. Product Data.
      j. Samples.
      k. Reference Submittals.
      l. Progress Photographs.

m. Special Guaranties and Warranties.
n. Updated Subcontractor List.

5. With Request for Final Payment
   a. As-Built Drawings.
   b. Final Affidavits and Waivers of Lien (see attached form).
   c. Complete package of Shop Drawings and Product Data conforming reproducibles.
   d. Final Photographs.
   e. Keys and Keying Schedule.
   f. Certificate of Inspection.
   g. Certificate of Occupancy.

1.2 PROGRESS SCHEDULES

A. Preliminary Construction Schedule

1. At fourteen calendar days following written Notice to Proceed, a Contract Milestone date has been established which is the Contractor's submittal to the Engineer for review and approval of an electronic PDF of a bar-chart schedule covering the first 45 calendar days of work to be performed, while the Detailed Construction Network is being prepared. A copy will be returned to the Owner, Field Representative, and each Contractor.
2. The Contractor shall submit to the Engineer for review and approval, with the Preliminary Construction Schedule, a detailed breakdown of the costs for all work activities identified in the schedule. The cost for each work Activity shall include mobilization, materials, labor, equipment, overhead, and profit. The Contractor will include the cost projections as part of the CPM Schedule or as a separate document that corresponds to the CPM Schedule. Cost breakdown must be consistent with the Pay Items of the base bid schedule. After review, any necessary revision, and approval, this cost breakdown will be utilized as the basis for review of progress payment estimates during the initial 45 days of the Contract prior to use of the approved Schedule of Values.
3. The Contractor shall revise the schedule and cost breakdown according to the comments received from the Engineer and submit an electronic PDF of the revised schedule and cost breakdown to the Engineer within ten calendar days after receipt. The reviewed schedule will then be considered the "Approved 45 Day Preliminary Construction Schedule."

B. Detailed Construction Network

1. The Detailed Construction Network in precedence format shall be a computer-generated and computer-drawn schedule analysis.
2. A Detailed Construction Network represents the Contractor's best judgment of how it shall prosecute and complete the work in compliance with the Contract Milestone Dates and any other Specific Dates stipulated in the Contract Documents.
3. The identity and duration of all Activities to be included in this Construction Plan. Activities shall meet the following criteria:
   a. Activities shall be numbered, and their descriptions shall be clear and concise. Where applicable, descriptions shall include quantities of work.
   b. Activities shall be coded with sufficient detail to allow identification of the Activity as to type of work, work responsibility, interfacing of the activity with other contracts, and any other coding necessary to accurately describe the work Activity. All Activities associated with the preparation, submittal and approval of

information required by the Engineer shall be coded so they may be readily identified.

c. Resource requirements (manhours by craft, material, equipment, services, etc.) shall be described for each Activity, in the resources dialog box.

d. The quantity and cost component for each Activity shall be provided. The sum of the Activity cost components shall equal the Contract Price. If the Contract calls for pay items, the Activity shall also be coded to allow identification with its respective pay item(s). Fabrication of materials and/or equipment shall be described in a separate Activity. The cost component of any fabrication Activity shall be zero.

4. The identity of long lead items and delivery dates of all major pieces of equipment or materials.

5. The identity of any potential problems or constraints related to the implementation of the overall construction plan.

6. All Activities included in the Preliminary Construction Network shall be included in the Detailed Construction Network.

7. The plot of the Detailed Construction Network shall:

   a. Show the interdependencies of the work Activities and the major points of interface or interrelation with the activities of others, including Specific Dates for completion.

   b. Indicate conformance with the specific interim Milestone Dates specified in the Contract Documents.

   c. Include the description and quantity of work, by Activity.

   d. Allow for the time required for engineering, preparation, submission, and approval of submittals (including O & M Instructions), manufacturing, delivery, and installation of Contractor-furnished permanent plant materials.

   e. Indicate required dates of delivery of Owner-furnished material and equipment. (If applicable).

   f. Delineate the critical Path (or Paths).

   g. Indicate all erection and installation Activities.

   h. Indicate all testing of equipment and materials.

   i. Indicate startup, operational demonstration, and commissioning Activities.

   j. Be furnished in color, with necessary legend sheets, and on electronic 22-inch x 34-inch sheets.

8. The Detailed Construction Network shall indicate late completion date for the project that is no later than the Project's required date for final completion. All Activity durations shall be given in working days. The Network shall also indicate each of the following:

   a. Interfaces with the work of outside entities, e.g., utilities, power, any separate contractors.

   b. Description of Activity, including Activity numbers.

   c. Estimated duration for each Activity.

   d. Early start date for each Activity.

   e. Late start date for each Activity.

   f. Early finish date for each Activity.

   g. Late finish date for each Activity.

   h. Float available for each path of Activities.

   i. Actual start date for each Activity begun.

   j. Actual finish date for each Activity completed.

k. The Critical Path for the project, with said path of Activities being clearly and easily recognizable on the time-scaled network diagram. The relationship between all non-critical Activities and Activities on the Critical Path shall be clearly shown on the plot of Detailed Construction Network by symbol.
l. The dollar value and quantity of work for each Activity, corresponding with the Schedule of Values.
m. The responsibility, by Contractor, Subcontractor, or Supplier, for each Activity or portion thereof.
n. The percentage complete for each Activity in progress or completed.

C. The Contractor shall submit with the Detailed Construction Network, an electronic PDF a narrative description indicating anticipated allocation of the following resources and work shifts to be utilized on the project:
1. Labor resources by each craft, representatives of the equipment manufacturers, and all other personnel that have been retained by the Contractor.
2. Equipment resources.
3. Whether work will be performed on a one, two, or three-shift basis.
4. The Contractors specific understanding of the effects of seasonal weather conditions on the scheduled work, and the anticipated measures the Contractor and all sub-contractors will exercise to accommodate the known local weather conditions.

D. It is to be expressly understood and agreed to by the Contractor that the schedule is an estimate to be revised from time-to-time as progress proceeds. The Owner does not guarantee that the Contractor can start work activities on the "early start" or "late start" dates, nor complete work activities on the "early finish" or "late finish" date as shown in the schedule, or as same may be updated or revised. The Owner or Engineer does not guarantee that Contractor can proceed at all times in the sequence established by said schedule.

E. Within 21 calendar days following Notice to Proceed, the Contractor shall also submit an electronic PDF of its proposed Schedule of Values (using the breakdown of the computer listing of Activities) to the Engineer. The Schedule of Values shall allocate a dollar value (cost) for each Activity of the Detailed Construction Network. Each Activity cost allocation shall include labor, equipment, and material costs, including a pro rata contribution for overhead and profit. The sum of all Activity costs shall be equal to the total Contract Sum. Each Activity cost shall be coded by the Contractor, to show which subcontractor is responsible for performing the work so that subtotals for each coded activity of the work can be prepared. The Contract Pay Item for each Activity shall be indicated. The sum of costs for each Pay Item shall equal the value submitted with the Contractor's proposal.

F. The Engineer will review the Contractor's Detailed Construction Network and Schedule of Values. The review of the Detailed Construction Network, including logic diagrams and computer generated mathematical analysis will be for compatibility with the required Project Construction and Commissioning Schedule. The review of the Schedule of Values will verify that the Schedule of Values shall, in the best judgement of the Contractor, and the Engineer, represent a fair, and equitable dollar value for each Activity on the Detailed Construction Network. The Contractor shall revise its Detailed Construction Network and Schedule of Values as required to support the Project Construction and shall resubmit them to the Engineer within ten calendar days for re-review. The Contractor's resubmittal shall include the following:
1. Plot of the Detailed Construction Network (electronic PDF).

2. Computer disks of the Detailed Construction Network (1 set).
3. Schedule of Values (electronic PDF).
4. Computer listings/supporting data (electronic PDF).

G. Within 10 calendar days following submission of an acceptable Detailed Construction Network and Schedule of Values, the Engineer will return an electronic PDF to the Contractor. The Contractor shall review these returned items and within five calendar days following the receipt from the Engineer signify its agreement by signing one copy of each document and returning it to the Engineer. Approval shall be signified by the Engineer also signing the copies of the documents which were signed and returned by the Contractor. The Contractor's approved Detailed Construction Network and Schedule of Values shall then be the documents which the Contractor shall use in planning, coordinating, and executing the work (including all activities of Subcontractors, equipment vendors and suppliers) and shall be the basis for evaluating the progress of the work and supporting requests for payment, subject to such revisions made in such schedule as are provided for in the Contract Documents.

H. Approval by the Engineer of the Contractor's Detailed Construction Network is advisory only and shall not relieve the Contractor of the responsibility for accomplishing the work within each and every Contract-required Milestone and Completion date. Omissions and errors in the approved Detailed Construction Network shall not excuse performance which is not in compliance with the Contract. Approval by the Engineer in no way makes the Owner, Engineer an insurer of the Detailed Construction Network's success or liable for resultant time or cost overruns attributable to its shortcomings. The Owner hereby disclaims any obligation or liability by reason of the Owner, or Engineer's approval of or acquiescence to the Detailed Construction Network.

I. Recovery Schedule
   1. If certain activities shown on the Contractor's Detailed Construction Network fall behind schedule, to the extent that any of the mandatory specific or milestone or completion dates are in jeopardy, the Contractor shall prepare and submit to the Engineer a Supplementary Recovery Schedule, in a form and detail appropriate to the need, which explains and displays how the Contractor intends to reschedule those activities, in order to regain compliance with the Detailed Construction Network during the immediate subsequent pay period. Both the preparation of the Recovery Schedule, and all necessary acts under that Recovery Schedule required to recover compliance with the mandatory dates, shall be at no additional cost to the Owner.
   2. The Contractor shall do the following after determination of the requirement for a Recovery Schedule:
      a. Within three calendar days, the Contractor shall prepare and complete the Recovery Schedule. The Contractor and major Subcontractors shall provide the Engineer with such information as is required to assist in review of the Recovery Schedule. The Recovery Schedule shall represent the Contractor's best judgment as to how it shall reorganize its work so that it may return to the Detailed Construction Network within the immediate subsequent pay period. The Recovery Schedule shall be prepared to a similar level of detail as the Detailed Construction Network and shall have a maximum duration of one month which shall coincide with the pay period.
      b. Within five calendar days, the Contractor shall participate in a conference with the Engineer to review and evaluate the Recovery Schedule. Any revisions necessary as a result of this review shall be resubmitted by the Contractor for approval

within two calendar days of the conference. The approved Recovery Schedule shall then become the Schedule which the Contractor shall use in planning, coordinating, and executing the work (including all activities of subcontractors, equipment vendors, and suppliers) for its one month duration, to regain compliance with the Detailed Construction Network.

c. Five calendar days prior to the expiration of the Recovery Schedule, the Engineer and the Contractor will meet at the job site for the monthly update and to evaluate the effectiveness of the Recovery Schedule, and shall determine whether the Contractor has regained compliance with the Detailed Construction Network. At the direction of the Engineer, one of the following will occur:
   1) If, in the opinion of the Engineer, the Contractor is still behind schedule, the Contractor shall prepare another Recovery Schedule, at the Contractor's expense, pursuant with this Paragraph, which will take effect during the immediate subsequent pay period. This schedule shall be prepared under the immediate review of the Engineer.
   2) If, in the opinion of the Engineer, the Contractor has sufficiently regained compliance with the Detailed Construction Network, the use of the Detailed Construction Network will be resumed.

J. Requested Time Adjustment Schedule

1. The updated Detailed Construction Network and accompanying reports submitted by the Contractor shall not show a completion date later than the stipulated completion date, subject to any time extensions approved by the Owner. If the Contractor believes it is entitled to an extension of the Contract Time under the provisions of the Contract Documents, the Contractor shall submit to the Engineer, with each progress payment update, a separate schedule analysis (entitled "Requested Time Adjustment Schedule") indicating suggested adjustments in the Contract Time which should, in the opinion of the Contractor, be made in accordance with the Contract Documents for time adjustments, which are due to changes, delays, or conditions occurring during the past month or previously, or which are expected or contemplated by the Contractor (whether such conditions are excusable under the Contract or are alleged to be due to Contractor or Owner fault). This separate schedule, if submitted, shall be a computer-generated and computer-drawn schedule analysis, and shall be accompanied by a formal time extension request, as required by the Contract and a detailed narrative justifying the time extension requested.
2. The time extension request shall include forecasts of the actual Project Completion Date, completion of any sequences of Activities required by the Owner, and a forecast of the resultant actual achievement of Milestones listed in the Contract.
3. To the extent any time extension requests are pending at the time of any update of the Construction Schedule, the "Requested Time Adjustment Schedule" shall also be updated to reflect any adjustments made by Contractor in the logic, sequence, or duration of any Activities, any time extensions previously granted by the Owner, and to reflect actual or expected progress, in order that the "Requested Time Adjustment Schedule" shall clearly and accurately reflect the Contractor's actual intention and proposed time adjustments.
4. Neither the Engineer or the Owner have any obligation to consider any time extension request unless the requirements of the Contract Documents are complied with. The Owner shall not be responsible or liable to the Contractor for any constructive acceleration due to failure of the Owner to grant time extensions. The Contractor's failure to perform in accordance with the approved Detailed Construction Network shall

not be excused, nor be chargeable to the Owner, simply because the Contractor has submitted time extension requests or the "Requested Time Adjustment Schedule."

K. Each request for payment submitted to Engineer for approval shall be accompanied by the individual Contractor's Progress Schedule. The Progress Schedule shall be that schedule required above. The schedule accompanying the request for payment shall indicate actual progress compared to that anticipated on each approved Contractor's Progress Schedule. If actual performance does not meet the performance as shown on the approved schedule in total or on individual line items, revise and submit evidence as to what efforts the individual Contractor will take to meet the approved schedule. Failure to submit the Progress Schedule with each request for payment shall be cause for not processing the request for payment until receipt of schedule as required above.

1.3 PROGRESS REPORTS

A. Each Prime Contractor shall provide the Engineer with a detailed progress report showing work completed the last month. Provide at each monthly progress meeting.

1.4 SHOP DRAWINGS, PRODUCT DATA, SAMPLES AND REFERENCE SUBMITTALS

A. Definitions
1. Shop Drawings are drawings, diagrams, schedules and other data specially prepared for the work by the Contractor or any Subcontractor to illustrate some portion of the work.
2. Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate a material, product or system for some portion of the work.
3. Samples are physical examples which illustrate materials, equipment or workmanship and establish standards by which the work will be judged.
4. Reference Submittals are any technical data or submittals listed in the technical sections of the Specifications, under Reference Submittals including but not limited to test reports, surveys, special guaranties and warranties, maintenance and operating instructions, extra stock, installers' certification, material certification, and calculations.
5. Shop Drawings, Product Data, Samples, and Reference Submittals are not to be construed as Contract Documents, they are to be used by the Contractor for his convenience only.

B. General Requirements
1. There shall be no substitutions for specified products, equipment, or systems except as allowed in Division 01 Section “Product Requirements”.
2. Shop Drawings and Product Data are solely the responsibility of the Contractor, and shall be checked by him. Engineer and Owner take no responsibility whatsoever for such documents submitted for review.

C. Shop Drawings

1. Prepare project specific information, drawn accurately and to scale. Do not base shop drawings on reproductions of the contract documents or standard printed data, unless otherwise permitted.
2. Only those Shop Drawings and Product Data will be reviewed:
    a. Where details of fabrication, installation or attachment are required to supplement the Contract Documents.
    b. Where there are deviations from the Contract Documents for any reason. (This procedure is not for the purpose of reviewing substitutions.)
    c. Where further documentation is required to show the proposed product or system is in conformance to every requirement of a performance Specification.
    d. Where listed under Submittals in each technical section.
3. Shop Drawings and Product Data shall be submitted in sufficient detail to permit the Reviewer to review:
    a. That product or system is as specified or shown.
    b. Details of fabrication, installation or attachment.
    c. For complete conformance to each requirement of performance Specifications, line item by line item.
4. Shop drawings shall fully illustrate all requirements in the contract documents. Include the following information, as applicable:
    a. General arrangement of each product or assembly by necessary plans, elevations and sections.
    b. Dimensions, finishes, part numbers, location in the building and details of fabrication and installation.
    c. Any equipment with electric motors or wiring must show wiring diagram and schematics. Lack of either will be cause for automatic rejection of the submittal.
    d. Identification of products.
    e. Schedules.
    f. Compliance with specified standards.
    g. Notation of coordination requirements.
    h. Notation of dimensions established by field measurement.
    i. Relationship and attachment to adjoining construction clearly indicated.
    j. Seal and signature of professional engineer, if specified.
5. Sheet Size: Except for templates, patters, and similar full-size drawings, submit shop drawings on electronic sheets at least 8-1/2 by 11 inches, but no larger than 22 by 34 inches.
6. Format: Submit shop drawings in PDF electronic format. At the Engineer's request, submit up to 3 hard copies.

D. Product Data
1. Product Data shall include the following information, as applicable:
    a. Manufacturer's catalog cut sheets
    b. Manufactuerer's product specifications and details
    c. Performance characteristics
    d. Wiring diagrams
    e. Test data
    f. Installation instructions
    g. Standard color charts
    h. Statement of compliance with specified reference standards
    i. Testing by recognized testing agency
    j. Application of testing agency labels and seals

k. Notation of coordination requirements
l. Availablilty and delivery time information

2. Product Data shall be submitted with a cover letter stating exact product by name and number and how it complies with the Contract Documents.
3. Format: Submit product data in PDF electronic format. At the Engineer's request, submit up to 3 hard copies.

E. Samples
1. Submit 3 identical sets for each material, finish and color required.
   a. For unit materials (such as brick, floor or ceiling tile), provide standard size units in sufficient quantity to show the full range.
   b. For finishes applied over large areas (such as wall covering, carpet, ceramic tile, plywood), provide 12-inch x 12-inch minimum size samples or larger, as required, to show full range or repeat pattern.
   c. For linear products, such as door and window frames or trim pieces, submit 12-inch minimum lengths of the actual product.
2. Full-Size Samples: Where required, submit a full-size unit of a specified product as a sample. Such sample may be used in the finished work if:
   a. It is approved for such use by Engineer.
   b. It is protected and in first-class condition.
   c. It matches the balance of the product used on the Project.

F. Reference Submittals
1. All calculations shall have the Professional Engineer's seal affixed, and shall be submitted prior to starting fabrication or installation. Engineer shall not be responsible for calculations of such other Professional Engineers. The Professional Engineer shall be registered in the State of Ohio.
2. Calculations, where required for the preparation of Shop Drawings, shall be submitted with those Shop Drawings and not as a separate submittal. Shop Drawings submitted without calculation backup sheets will be returned unreviewed.

G. Submittal Process
1. As soon as practical after executing the Contract, or as required by other Contract Documents, request from each Subcontractor and submit properly processed and identified items as required in the Specifications.
   a. Late or untimely submittal of information shall not be cause to reduce Engineer's review time, to accept lower quality, or to delay the project completion.
2. Contractor shall be solely responsible for scheduling and coordinating of submittals among Subcontractors.
3. Allow a minimum of 14 working days for processing (from the date the Reviewer receives submittal until the date he sends it back) and sufficient time for proper handling, review, fabrication and delivery. If many items are submitted simultaneously, substantially more time for processing shall be required if Engineer so determines.
4. Send a separate Transmittal Letter with each submittal by specification number, using the form provided by the Engineer. List and identify each item on the Transmittal Letter. Include Engineer's project identification number and other requested information on the transmittal letter or on the submittal being sent.
5. When Shop Drawings are revised and resubmitted, all the revised, added and/or deleted items since the previous submittal must be circled by the submitter.

6. The entire submittal of Shop Drawings will be returned unreviewed when revised, added and/or deleted items have not been circled.
7. Shop Drawings that are submitted for reference as an aid to review another portion of the work will not be reviewed.

H. Form of Submittal
1. Shop Drawings shall be submitted in PDF electronic format. The sheet size of the electronic PDF shall generally be 22-inch x 34-inch or 11-inch x 17-inch and shall be filled completely to minimize the number of sheets.
2. Submittals for Product Data shall be submitted in PDF electronic format. The sheet size of the electronic PDF shall generally be 8-1/2-inch x 11-inch.
    a. Provide minimum blank space of 3-inch x 8-1/2-inch on each submittal for review stamps of Contractor and Engineer.
    b. When submitting product data, submit only catalog pages showing the item to be furnished and identify the item on the page and on a separate cover letter stating how it complies with the Contract Documents.
3. Where Samples are requested, submit three complete sets of the sizes indicated.
4. Mark each item with the same identifying number used on the Transmittal Letter and include the following information:
    a. Project name and number
    b. Contractor's name, address and telephone number
    c. Subcontractor's name, address and telephone number
    d. Supplier's name, address and telephone number
    e. Date of submittal
    f. Specification section number or Drawing number
    g. Status (new or prior submittal date and number)

I. Contractor's Check
1. Upon receipt of submittals, check each item for:
    a. Conformance to submittal requirements
    b. Conformance of materials and details to the Contract Documents
    c. Accuracy of all measurements
    d. Field construction criteria related thereto
2. Reject items which do not conform to these requirements and return them to the originator with an explanation for the rejection. Do not submit rejected items to Engineer.
    a. Do not submit Shop Drawings, Product Data, or Samples that are not requested in the Technical Sections.
3. For items approved by the Contractor, stamp each item "APPROVED" to warrant and represent approval.
4. Contractor is totally responsible for the following items which will not be reviewed by the Engineer or by Owner:
    a. Deviations from Contract Documents.
    b. Dimensions to be confirmed and correlated at the Site.
    c. Fabrication process information
    d. Means, methods, techniques, sequences, procedures of construction and construction safety.
    e. Coordination of the work of all trades.
    f. Reference Submittals

J. Engineer's Review
   1. Deliver or send each item, shipping charges prepaid, to Engineer.
   2. Engineer immediately will reject any item without further review if it is not:
      a. Accompanied by a Transmittal Letter containing the required information
      b. Submitted as a reproducible
      c. Stamped "APPROVED" by the Contractor
   3. If the submittal has been previously submitted and was marked "CONFORMS" or "CONFORMS AS NOTED" and the transmittal letter does not state that additional corrections or additions to the submittal have been made, then such submittal shall not be reviewed again.
   4. Review will be for conformance to the design concept and compliance with information given in the Contract Documents. Engineer will make notations directly on the electronic PDF copy.
   5. Review is intended to foresee unacceptable products and to minimize the possibility of their rejection at the Site. The review shall not be construed as:
      a. Permitting a departure from the Contract Documents, unless specifically so noted.
      b. Relieving the Contractor of responsibility for errors or omissions.
      c. Acceptance of an assembly of which an approved item is a part.
      d. Approval of variations from previously approved items.
      e. Approval of dimensions.
   6. Engineer will review all Samples. Such review will be for appearance only. Compliance with all other requirements of the Contract Documents is the responsibility of the Contractor.
   7. Product Data: Only the cover letter will be stamped with the Shop Drawing stamp, and not the product data sheets.
   8. Reference Submittals shall be sent to Engineer for informational purposes only.
      a. Refer to Technical Sections under Reference Submittals for required information to be submitted.
      b. The contents of such submittals and compliance with all other requirements of the Contract Documents shall be the responsibility of the Contractor.

K. Variations from Contract Documents
   1. If Engineer determines a variation from the Contract Documents is in the best interest of the Owner, and it does not involve a change in the Contract price or time, he may permit such variation and stamp the item "CONFORMS".
   2. Unless Engineer receives immediate written notification, he will assume the Contractor approves any variation shown.
   3. If Contractor fails to mention variations from the Contract Documents, he will not be relieved of responsibility for executing the work in accordance with the Contract Documents.
   4. When a variation from the Contract Documents is permitted and such variation involves corresponding adjustment in an adjacent or related item, responsibility for making and paying all costs for such adjustment rests with the Contractor requesting the original variation. Additional services required of Engineer, shall be paid for by Contractor. Payment for such additional services shall be made as follows:
      a. Owner shall compensate Engineer for such additional services and Owner shall deduct amount of such compensation from payments due to the Contractor.

L. Reviewer's Stamp and Letter of Acknowledgement

1. Each Shop Drawing, Product Data cover letter or Sample processed by Engineer (except reference submittals).
2. If the item conforms to all requirements of the Contract Documents or if the item contains permitted variations, it will be stamped "CONFORMS".
3. If the item is marked-up by the Contractor or Engineer to make it conform and such mark-ups are not extensive, it will be stamped "CONFORMS AS NOTED".
4. If the item does not conform to the Contract Documents and the variation is not permitted, or if the item is extensively marked-up, it will be stamped "DOES NOT CONFORM".
5. Except for field test reports, receipt of Reference Submittals will be acknowledged by Letter of Acknowledgement and no stamp will be placed on such submittals. Sample attached at the end of this Section.

M. Rejection and Resubmittal
1. Items which do not meet the requirements of this Section, or are stamped "DOES NOT CONFORM", will be returned for correction and resubmittal by the same process. Engineer will indicate reasons for the rejection and will retain one print or sample to check against resubmittal.
2. Any item not prepared as required by the Contract Documents or not prepared in a professional or workmanlike manner requiring excessive review time, including items that require more than 2 submittals, shall be assessed a back charge by Owner for such extra time. Payments for such additional services shall be made as follows:
    a. Owner shall compensate Engineer for such additional services and Owner shall deduct amount of such compensation from payments due to the Contractor.
3. Make the indicated changes only, unless further change is required for conformance to the Contract Documents.
4. Direct attention on the item to all revisions. Explain all revisions, other than those requested, in detail on the transmittal form.
    a. All revised and/or added items since the previous submittal must be circled.
    b. The entire submittal will be returned unreviewed when revised or added items have not been circled.
5. Contractor shall be completely responsible for changes not indicated or specifically noted as revised.

N. Acceptance and Use
1. Items stamped "CONFORMS AS IS" or "CONFORMS AS NOTED" will be returned to Contractor.
2. Distribute electronic copies as required to transmit the information to all parties involved.
3. Engineer will retain conforming Shop Drawings and Product Data as well as one sample, for comparison with work installed.
4. Keep copies of each approved item on the job Site at all times for reference.
5. Retain the original electronic submittal until Final Completion of the work and turn them over to Engineer for the Owner's file.
6. Do not commence work requiring Shop Drawings, Product Data, Samples, and Reference Submittals until submittal has been processed by Engineer. Perform all work in accordance with such submittal.
7. No work shall be performed without a required submittal having the proper Engineer stamp stating "CONFORMS" or "CONFORMS AS NOTED".

1.5 QUALITY CONTROL SUBMITTALS

A. Certificates
   1. Installer Qualification is required for all installers of product systems listed as requiring such in the "Submittals" paragraphs of the technical specifications. Installer Certification shall consist of written certification from the manufacturer of the product system listed certifying that the Installer is approved by the manufacturer for installing the specified product system. Submit an electronic PDF copy of certification with the Subcontractor and Material List prior to Contract signing.
   2. Material Certification is required for all materials listed as requiring such in the "Submittals" paragraphs of the technical specifications. Material Certification shall consist of written certification from the manufacturer of the material listed certifying that all such material used in the work meets the requirements specified in the Contract Documents and is being utilized in conformance with the manufacturer's recommendations. Submit electronic PDF copy of certification as work progresses.
   3. Surveyor's Certification
      a. A certification shall be a written statement certifying the correctness of the data reported and sealed by a surveyor registered in the state where the project is located. A report shall consist of reduced field notes, sketches, or dimensions marked on copies of the Construction Drawings.
      b. Contractor shall submit certifications during the construction of the Project from a registered surveyor that the critical locations and elevations of the construction are in accordance with the Contract Documents.
         1) Items for certification shall include, but not be limited to, all structures, pipes, utilities, and other underground and aboveground construction, such as bottom of footings, top of footings, floor elevations, elevations of pipe centerline.
         2) Report all deviations from the Contract Documents both critical and those that are not critical.
      c. Report horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
      d. Report location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
      e. Reports shall be submitted timely before and after construction. For example report and certify footing locations before and immediately after construction of the footings.

B. Manufacturer's Instructions
   1. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including a PDF electronic copy to the Engineer.
      a. Maintain 1 set of complete instructions at the jobsite during installation and until completion.
   2. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.
      a. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the Engineer for further instructions.
      b. Do not proceed with work without clear instructions.

3. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

1.6 INFORMATION REQUESTS, AND PROPOSED DEVIATIONS

A. General: Questions which arise during construction concerning the Contract Documents and the interpretation thereof, shall be submitted in writing to Engineer for his comments. Questions that can be answered by review of the Contract Documents shall not be submitted to Engineer.

B. Proposed Deviation
   1. Questions concerning proposed deviations from the Contract Documents to accommodate construction shall be documented and submitted to the Engineer for his review.
      a. Such documentation shall include a proposed solution with detailed drawings and written substantiation for the proposed deviation.
      b. This shall not be construed as a means of submitting substitutions of manufacturers, products, materials, equipment, or systems. Substitutions shall not be submitted except as permitted in Division 1 Section “Material and Equipment”.
   2. Do not proceed with such deviations until written notice to proceed has been received from Engineer.
      a. Such written notice shall not relieve Contractor from conformance to the Contract Documents.
   3. All reviews by Engineer of proposed deviations submitted by Contractor which would provide any benefit to Contractor and all reviews by Engineer of requests for deviations which are, in fact, requests for substitutions shall be paid by Contractor, even though the request may be denied, as follows:
      a. Owner will compensate Engineer.
      b. Owner will deduct the amount of such compensation from payments to Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 3300

SECTION 01 4500

QUALITY CONTROL

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 QUALITY ASSURANCE

A. General: The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work. The Contract Documents are complementary, and what is required by any one shall be as binding as if required by all. Work not covered in the Contract Documents will be required if it is consistent therewith and is reasonably inferable therefrom as being necessary to produce the intended results. In case of a discrepancy between the Drawings and Specifications or among Drawings, the strongest, the larger quantity or better quality, as determined by the Interpreter shall govern. If an item is shown on the Drawings, but not specified, the Contactor shall provide the item of a quality similar to other items specified, as determined by the Interpreter. If an item is specified, but not shown on the Drawings, it shall be located as required by the Interpreter.

B. Wind Load: Provide products designed to withstand the indicated wind load; when requested, submit substantiating data.

C. Fire Resistance Rating: Provide materials and assemblies which have been tested and listed by UL, FM, IRI, OIA, or other recognized authority, for the assembly shown or specified; where specified, attach label of testing authority. For oversized assemblies or assemblies similar to those tested, provide Manufacturer's certification that the assembly has been constructed of materials and methods equivalent to the tested construction.

D. Flame Spread Rating: Provide products with the indicated flame spread rating or less; when requested, submit substantiating data. Provide materials with flame spread ratings required by code, unless a more strict requirements is specified.

E. Proprietary Products: Where systems or assemblies of materials or equipment are indicated, obtain all primary components from the same Manufacturer, unless specifically noted otherwise.

1.3 TESTING LABORATORY

A. The Owner shall coordinate and provide all testing services, including soil testing and concrete testing, except that which may be specifically specified otherwise in the technical sections.

1.4 INSPECTION SERVICES

A. Perform or arrange for all inspections, tests, and approvals required in each Technical Section or by governing authority.

B. Pay all costs unless specifically stated otherwise in the Technical Sections.

C. Notify each inspecting authority, Engineer, and Owner 24 hours in advance of each test, inspection and approval.

D. Keep records of each test, inspection and approval. Include the time, weather conditions, name of inspecting, testing, or approving authority, results of the test, and all other pertinent data.

E. Submit official reports showing dates performed, test methods, results, interpretations of results, and recommended actions. Submit required copies to governing authorities, Engineer, and Owner.

F. Provide required certificates to Engineer and Owner for the Owner's file.

G. If Engineer determines that any work requires special inspection, testing, or approval he will, upon written authorization from Owner, instruct Contractor to order such special inspection, testing, or approval. If such special inspection or testing reveals a failure of the work to comply with requirements of the Contract Documents, Contractor shall bear all costs thereof, including compensation for additional services of Engineer; otherwise, Owner shall bear such costs, and an appropriate Change Order shall be issued.

1.5 CONTRACTOR'S QUALITY CONTROL

A. Temperature and Humidity
   1. Maintain a daily log of outdoor and indoor high/low temperatures and general weather conditions. Such log shall be readily accessible to Engineer.
   2. Provide accurate outdoor and indoor thermometers at the Site.
   3. Do not install products in or on structures in temperatures or moisture conditions outside the recommended ranges.
   4. Maintain proper ambient and material temperatures and moisture conditions as required by product Manufacturers and other standards, by use of temporary heat, ventilation, construction of temporary structures, or by other approved means.
   5. If low temperatures make it impossible to continue operations safely, in spite of cold weather precautions, cease Work and notify Engineer.
   6. Where a substrate or product is recommended to be dry or a moisture content is listed for installation procedures, conform to the requirements. If actual conditions do not meet the standards, reduce moisture in products or substrate by approved artificial methods when natural processes would delay the progress of the Work.

B. Power Characteristics
   1. Refer to Division 26 for project power characteristics.
   2. Motors, starters, safety switches, pushbuttons, pull cords, internal wiring and operating devices, and low voltage wiring are the responsibility of each Contractor providing a product requiring electrical service.
   3. All conduit, wiring, and interlocking required to complete the installation are the

responsibility of the Electrical Contractor.

1.6 MANUFACTURER'S FIELD SERVICES

A. General
   1. When indicated in the technical specifications, provide a qualified technical representative at the Site to advise on the proper installation of the product.
   2. Representative shall check the installation of the equipment, supervise its initial operation and initial testing and instruct operating personnel in its operation and maintenance.
   3. Representative shall supervise necessary adjustments to insure satisfactory operation.
   4. Some of the technical sections require a minimum number of hours or days for the Representative to remain on the Site. This time must fall within the normal construction day. If a longer time or overtime is required it shall be provided at no increase in cost to the Owner.
   5. Representative shall remain on the Site or make as many return visits as necessary to insure the equipment is operating properly.
   6. If the service includes coordination, calibration, etc. with another Manufacturer's connecting equipment, the Contractor shall arrange for those Representatives involved to be on the Site at the same time.
   7. Where the supervision of a Representative is not called for in the technical specifications, this shall in no way relieve the Contractor of his responsibility to properly construct or install equipment or material in accordance with the Contract Documents.
   8. Contractor shall make arrangements with the Representative and notify Engineer at least five days in advance of each visit.
   9. Report Form: Where a Report Form is required in the Technical Specifications, the Representative shall complete and submit a "Manufacturer's Service Representative's Report" using the form attached at the end of this Section. A separate Report shall be required for each piece of equipment and each visit. Contractor shall submit 3 copies of the signed Report Form within 5 days of the visit. Contractor shall furnish all necessary copies of the attached form.

B. Training
   1. For major pieces of equipment and SCADA systems, there shall be training session(s) provided by the manufacturer or Contractor.
   2. An outline shall be provided showing, as a minimum, basic function, start-up procedures, normal operating procedures, and normal maintenance.
   3. The Contractor shall record video, with audio, each session. There shall be a separate DVD or other electronic video media for each piece of equipment, unless otherwise noted or approved.

1.7 CONTRACTOR DESIGN RESPONSIBILITIES

A. The design of all pre-engineered elements, assemblies, components and connections of all types not designed by the Engineer shall be the total responsibility of the Contractor. Such shall include, but shall not be limited to, structural steel, precast concrete, wall panels, windows, architectural items, mechanical items, and electrical items. Engineering required for such for which all or a portion of the necessary engineering services are performed by the Manufacturer shall be the total responsibility of the Contractor. Where the Contract Documents require the design of architectural, structural, mechanical, or electrical items by a supplier, or where a

Contractor initiates a change in the design of a system or component thereof, such design shall be the total responsibility of the Contractor.

B. All Contractor design responsibilities shall be performed by a Registered Professional Engineer. Submit all calculations to Engineer for his records as a Reference Submittal prior to starting fabrication or installation of the Work. Engineer shall not review, check, or approve such submittals. Engineer will not be responsible for designs of others, including those of the Contractor, Subcontractors, and suppliers.

1.8 JOB CONDITIONS

A. Existing Conditions
   1. Condition of existing Structure and Site will be maintained as far as possible by the Owner up to the time the Work commences. However, variations may occur after inspection of the premises by the Bidder, due to Owner's removal and salvage operations. Owner assumes no responsibility for actual conditions at the time Work commences.
   2. Execute Work in connection with the existing building, as indicated. Report any marked discrepancy between the Drawings and actual conditions at the Building to Engineer or adjustment.
   3. All material removed by the Contractor unless otherwise specified, becomes his property and shall be removed from the premises promptly.

1.9 FAULTY AND NON-CONFORMING WORK

A. Faulty work or work not in conformance with the Contract Documents shall not be permitted.

B. Remove such work or propose a remedy by means of detailed drawings and written documentation and submit such documentation to the Engineer for his comments.

C. All costs for removal and reconstruction of such work, and additional services of the Engineer shall be paid by the Contractor. Payments for such additional services of the Engineer shall be made as follows:
   1. Owner will compensate Engineer.
   2. Owner will deduct the amount of such compensation from payments to the Contractor.

END OF SECTION 01 4500

SECTION 01 6000

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 FABRICATION

A. Fabricate all items in the shop insofar as possible. Where items cannot be completely shop-fabricated and assembled for shipment, assemble and fit in shop, disassemble and ship. Identify parts for field assembly. Fabricate items to be straight, square, in proper alignment, and with hairline joints where joints are necessary. Pre-plan field joints to be as inconspicuous as possible.

1.3 SHOP PRIMING

A. Shop prime or seal surfaces of all products to receive paint materials in accordance with requirements of the Contract Documents. Apply a primer or sealer compatible with the specified paint materials. If such primer is determined to be incompatible with the specified paint materials, provide a barrier coat or remove the primer and prime again as required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Packing: Deliver products in properly identified original packages or other containers with unbroken seals and manufacturer's labels, grade marks and other means of identification in place.

B. Shipping/Delivery
   1. Protect products during shipment to maintain the product's original characteristics.
   2. Deliver materials and equipment which will require controlled storage conditions on Site after the controlled storage provisions have been made on Site.
   3. Deliver materials, supplies, or equipment to Project site during working hours.
   4. Deliveries made during other than normal working hours must be received by an authorized agent of Contractor involved or be received by other means which shall be the sole responsibility of that Contractor.
   5. No employee of the Owner or Engineer is authorized to receive any shipment designated for this Project.
   6. The Owner or Engineer assumes no responsibility for receiving any shipment designated for this Project.
   7. Any materials delivered in the presence of Owner's or Engineer's representative shall be accounted for by the respective Contractor.
   8. Under no circumstances may shipments be directed to, or in care of, the Owner.
   9. Each Contractor, Subcontractor, manufacturer, or supplier furnishing materials to the site shall identify, ship, address, consign, etc. all such materials to the Contractor who may

be charged therewith by giving the name of the Contractor, the name and address of the Project.

C. Unloading and Acceptance
   1. Deliver products in properly identified original packages or other containers with unbroken seals and manufacturer's labels, grade marks and other means of identification in place.
   2. Check each item for completeness of order, physical condition and conformance to the Contract Documents. Reject products which do not conform to these requirements, or which have been damaged beyond repair or restoration to original condition as approved by Engineer.

D. Protection
   1. Protect products during shipment and on Site to maintain the original product characteristics.
   2. Protect all finished surfaces from damage during installation. Provide protective devices as required and as recommended by the manufacturer. Cover work subject to damage at the end of each day's work.
   3. Coat concealed surfaces of metal products with a bituminous or other approved coating to prevent contact between dissimilar metals or other material which can cause deterioration.
   4. Correct damage by repairing or replacing as required by Engineer. Repairing will be permitted only where the repair is undetectable and does not cause structural damage or interfere with proper functioning of the part.
   5. Protect finish of installed products until Substantial Completion of the Project by use of wrappings, covers, or other approved protective devices. Remove such protection immediately prior to final cleaning.

E. On-Site Storage
   1. Store hazardous products, such as paint materials, in well ventilated areas in accordance with applicable standards and governing laws.
   2. Store materials off the ground and in a manner to prevent damage or intrusion of moisture or other foreign matter.
   3. Cover materials which may be damaged by weather, allowing for proper circulation of air.
   4. When possible, store materials inside the building or in sheds.
   5. When storing materials in the building, stockpile materials in a manner which will not overload the structure.
   6. Store all materials in a manner immediately accessible for inspection.
   7. Store small items, such as finish hardware and other items easily stolen or vandalized, in a security area. Where possible, do not deliver such items until immediately prior to installation.

1.5 INSTALLATION STANDARDS

A. Examination of Substrate: Examine the substrate or structure to which a product is to be applied or installed. Check the substrate or structure for proper clearances and tolerances. Tolerances are listed in each Section. Do not proceed until unsatisfactory conditions have been corrected. Starting the work indicates acceptance of conditions and the installer assumes full responsibility for results.

B. Preparation
   1. Substrate: Where products are applied to a substrate, prepare the substrate as recommended by the product manufacturer, generally as follows:
      a. Bring substrate to a uniform surface by smoothing uneven surfaces and filling holes, cracks and low places with recommended filler or parent material.
      b. Remove substances, such as dust, oils and other foreign matter, not compatible with the product.
      c. Surfaces shall be dry, unless a moisture content or wetting is specified.
   2. Inserts and Anchorages
      a. Installer shall furnish built-in fastening devices for his product to the proper trade for installation as the work proceeds.
      b. If such devices are not furnished in time to be built in, installer shall provide alternate methods for attaching his product. Submit Drawings and other required data as Reference Submittals.
   3. Templates: Provide templates, diagrams and other coordinating documents to the proper Contractor, manufacturer, or supplier of related items affecting the work.
   4. Dimensions
      a. If the exact location of an item is not indicated by dimension on the Drawings or noted in the Specifications, Engineer reserves the right to determine such location in the field prior to roughing in.
      b. If the exact dimensions of a product are not indicated, Engineer reserves the right to determine dimensions prior to ordering or fabricating the product.
      c. Such dimensional changes shall not be a basis for changes in the Contract Sum.
      d. Where miscellaneous devices, such as thermostats, switches, controls, grilles, pipes, or outlets of any nature are not exactly located by the Contract Documents, request such location or obtain approval of the location prior to installation. If approval has not been obtained, Engineer may require the relocation of such devices at the expense of the installer.

C. Installation
   1. Install products in accordance with the manufacturer's recommendations or the requirements of trade associations, listed standards, conforming Shop Drawings, and Contract Documents. Where a conflict exists between these references, the most strict requirements govern. If printed instructions are not available, consult with the manufacturer's field representative.
   2. Provide hangers, auxiliary framing, and other means for installing ceiling suspension systems, lighting fixtures, diffusers, and other equipment in ceilings to avoid ducts, piping, etc.
      a. Suspend from structural members, such as joists or beams, and not from ducts or piping.
   3. Install work in a manner which will not interfere with the proper installation of the work of other trades and to facilitate operating, servicing, and repairing.
   4. Install products straight, plumb, level, and in line. Securely attach items to the substrate, using recommended adhesives, mechanical fasteners or other devices. Where holes are provided for attachment, do not field drill or cut new holes without approval of Engineer.
   5. Match all finished work to the submitted Samples or Sample panels.
   6. Conceal fasteners wherever possible, unless exposed fasteners are permitted or specified.
   7. Weld in accordance with AWS standards for qualifications of operators and for workmanship.

1.6 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to Instructions to Bidders for requirements and approval process of substitute materials, products, and systems.

B. Manufacturers, Products, Materials, Equipment and Systems
   1. General: Where more than one manufacturer, product, material, equipment item, or system is indicated as acceptable, provide any one named. No substitutions will be permitted after signing the Contract.
   2. Contractor's Option
      a. In many instances this Project has been designed around a specific manufacturer with other manufacturers listed as acceptable.
         1) Products from such other listed manufacturers will be accepted contingent upon meeting the design, appearance and functional standards established by the specified items.
      b. If any changes to the Contract Documents or work are required to accommodate an acceptable product of one such other listed manufacturer, the Contractor whose product requires such changes shall pay all additional costs involved with no additional cost to the Owner or Engineer. Such additional costs to be paid by such Contractor shall include, but not be limited to, all additional costs required for changes in the work of such Contractor and of all other Contractors as well as all costs for additional services of the Reviewer to review such changes.
      c. Payments for such additional services of the Reviewer shall be made as follows:
         1) Owner will compensate Engineer.
         2) Owner will deduct the amount of such compensation from payments to the Contractor.
   3. Unavailability of Product: When all of the products listed in the Contract Documents for a specified item are no longer being manufactured, or when products are not listed and all of the conforming products of manufacturers listed in the Contract Documents for a specified item are no longer being manufactured, then submit, through the Change Order process, the name of another product and manufacturer for review and approval by the Reviewer. Submit all documentation required elsewhere in the Contract Documents and as required by the Reviewer to show proof that the submittal is an equal in every respect to the item specified.
   4. Performance Specification: Where a performance is specified and no manufacturer is listed, submit through the Shop Drawing procedure the name of the manufacturer, the product proposed, and detailed information showing its characteristics.
   5. Color, Pattern, Texture: Where a choice of color, pattern, or texture is available for a specified product or item of equipment, the Reviewer will make a selection from the manufacturer's highest or best standards, unless noted otherwise in the technical sections of the Project Manual.

END OF SECTION 01 6000

SECTION 01 7823

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 REFERENCES

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 GENERAL

A. Submittal of operation and maintenance data shall be made to the Engineer on specified product items as outlined herein.

1.3 OPERATION AND MAINTENANCE MANUALS

A. Required where specified in technical sections.

B. Submit written instructions for operating each piece of equipment and for maintaining equipment. At the time of inspection for substantial completion, Engineer will notify Contractor of any revisions, corrections or incomplete data required for the satisfactory completion of the Operation and Maintenance Data Reference Manual. Engineer will not recommend final acceptance of the work until the Operation and Maintenance Data Reference Manual is complete and satisfactory to him.

C. Submit Operations and Maintenance Manuals when the equipment is delivered to the Job Site. Failure to deliver manuals may be cause to withhold payment for equipment.

D. The Operation and Maintenance Data Reference Manual shall contain, but is not limited to, the following information on all equipment and accessories furnished and installed under these Specifications:
   1. Equipment function, normal operating characteristics and limiting conditions for all equipment furnished.
   2. Detailed assembly, installation, alignment, adjustment and checking instructions for all equipment furnished.
   3. Detailed operating instructions for start-up, calibration, routine and normal operations, regulation and control, shutdown and emergency conditions for all equipment furnished.
   4. Detailed lubrication instructions and schedules for all equipment furnished including identification of lubricant (description, specification and trade name of at least two manufacturers), and diagrams illustrating lubrication points.
   5. Detailed guide to "troubleshooting" for all equipment furnished.
   6. Detailed parts lists identified by generic title, materials of construction and part number (actual manufacturer's number, not supplier's), list of recommended spare parts identified as specified above, predicted life of parts subject to wear and an exploded view of each equipment assembly for all equipment furnished.
   7. Electrical and instrumentation schematics for all equipment furnished including motor control centers, control panels, instrument panels and analyzer panels.
   8. List of all special tools required and description of their use for all equipment furnished. Special tools include any tool not normally available in an industrial hardware store.

9. Detailed preventive maintenance procedures and schedules for all equipment furnished.
10. Detailed list of settings for relays, pressure switches, temperature switches, level switches, thermostats, alarms, relieve valves, rupture discs, etc.
11. List of names and addresses of nearest service centers for parts, overhaul service.
12. One copy of any instructions and parts lists attached to equipment when delivered.
13. Procedures for storing, handling and disposing of any chemicals or products used with the equipment or system.

E. Assembly of Operation and Maintenance Data Reference Manual
1. Submit 1 preliminary copy of each manual in electronic PDF format to Engineer prior to date of shipment of the equipment
2. Three (3) final copies of each O&M manual shall be submitted, directly to the Owner, using loose-leaf binders. Binders shall be three-ring, hardback type, with a transparent vinyl pocket on the spine for label.
3. Each copy of the data reference manual shall be assembled in one or more loose-leaf binders, each with title page, typed table of contents, typed list of tables, typed list of figures and heavy section dividers with copper or mylar reinforced holes and numbered plastic index tabs. All data shall be punched for binding and composition and printing shall be arranged so that punching does not obliterate any data. The binding edge of each manual shall have the project number and title, specification division number and title and manual title printed thereon, all as approved by the Engineer.
4. List for each product, the name, address, and telephone number of the Subcontractor, Maintenance Contractor and source of supply.
5. Products not installed shall be removed from the Manual.
6. Provide manufacturer's recommended cleaning materials and methods.
7. All copies of Shop Drawings, figures and diagrams shall be reduced to either 8 1/2 by 11 inches or to 11 inches in the vertical dimension and as near as practicable to 17 inches in the horizontal dimensions. Fold such sheets to 8 1/2 by 11 inches. Print the manual and other data on first quality paper, 8 1/2 by 11 inch size with standard three-hole punching. Reduce drawings and diagrams to 8 1/2 by 11 inches or 11 by 17 inches. Label binders Vol. 1, Vol. 2, etc., where more than one is required. The table of contents for the entire set, identified by volume number, shall appear in each binder. Text, figures and drawings shall be clearly legible and suitable for dry process reproductions.

F. Electronic Format
1. The Contractor shall provide a USB drive(s) containing all the elements of each approved O&M Manual.
2. The contents of the electronic format shall be the same as the approved O&M Manual.
3. All text based documentation (i.e., specs, O&M, MSDS sheets, data sheets, etc.) shall be delivered on the USB drive in PDF format.
4. All pictures, graphs, or anything that is not a drawing shall be delivered on the USB drive in either a TIFF, JPEG, or GIF format.
5. All CAD drawings shall be delivered on the USB in AutoCAD 2016 or higher format.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 7823

SECTION 26 0505

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to implement the following general administrative and procedural requirements in accordance with the plans and as specified herein.

B. Extent of Work: Work under this contract consists of furnishing, installing, testing, placing into operation, and guaranteeing complete electrical systems, as shown on the drawings and as specified in Division 26. The Contractor shall connect and place all wired equipment in proper working order. Refer to the plans and specifications for work included in this Contract. Some general guidelines to coordinating work between Division 26 and other Divisions are as follows:

1. Division 26 includes all power wiring and raceways for equipment furnished under other Divisions. Motor starters and disconnect switches for Division 23 equipment shall be provided under Division 26 unless otherwise noted. Remote two-wire control logic will be extended to the motor starters as work of Division 23. Where combined line voltage power/control is used for Division 23 equipment, the wiring and raceways are treated as power wiring and are work of Division 26.
2. Division 26 is responsible for providing appropriate wire and conduit between all distribution equipment and all electrical devices and utilization equipment shown on plans. It is also the responsibility of Division 26 to provide all wire, conduit, and devices necessary to accomplish all control functions as indicated by the control diagrams which are not specifically shown as work of another division.
3. Division 26 provides all power wiring and raceways for plant equipment provided under Division 40. Division 26 provides all control, signal, and communication wiring and conduit for the instrumentation and control equipment provided under Division 40

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

1. All work shall be installed in full accordance with the latest edition of the National Electrical Code (NEC) as prepared and published by the National Fire Protection Association (NFPA) and any applicable local or state codes. All electrical equipment shall be listed and labeled by Underwriters' Laboratories, Inc. (UL) or any approved independent nationally recognized electrical testing laboratory where such standards exist. Optionally, in lieu of such listing and labeling, equipment pre-approved by the Electrical Inspector may be supplied. Wherever UL compliance is mentioned in the

specifications, the above alternatives shall be understood to apply to all listing and labeling requirements. This does not preempt or replace the specifications or replace the approval process. All service switches/circuit breakers shall be listed and labeled as outlined above for service entrance duty.

2. Comply with the requirements of NFPA Code 241 "Building Construction and Demolition Operations," the American National Standards Institute (ANSI) A10 Series standards for "Safety Requirements for Construction and Demolition," and the National Electrical Contractors Association (NECA) National Joint Guideline NJG-6 "Temporary Job Utilities and Services."
3. In addition to the requirements outlined under other sections of the Contract Documents, all Work, material, and equipment shall comply with all requirements of the latest editions and interim amendments of the National Electrical Safety Code, National Fire Protection Association, OSHA, the building Owner's insurance company, and all applicable federal, state, and local laws and ordinances. All materials shall be listed and labeled by UL and installed as required by the listing.
4. Should any changes in the Drawings or the Project Manual be required to conform to the above regulations, the Contractor shall notify the Engineer at the time of submitting his bid. After entering into the Owner-Contractor Agreement, the Contractor shall be held to complete all Work necessary to meet these requirements without additional expense to the Owner.

B. Permits and Regulations

1. The Contractor shall obtain all permits and inspections required by laws, ordinances, rules, regulations, and public authority having jurisdiction and shall obtain certificates of such inspections and shall submit same to the Engineer and shall pay all fees, charges, and expenses in connection therewith. The Contractor shall furnish to the Owner a certificate of final inspection from the proper authority prior to final payment. Obtain and pay for easements required to bring temporary utilities to the site, where the Owner's easement cannot be utilized for that purpose.
2. The Contractor shall not allow or cause any of the Work to be covered up or enclosed until the Engineer or Owner has been notified and given reasonable opportunity (2 working days) to review the Work. When required by law or regulations, the governmental agency having jurisdiction for inspections shall be given reasonable notice and opportunity to inspect the Work. Any Work that is enclosed or covered up before such inspection and test shall be uncovered at the Contractor's expense; after it has been inspected, the Contractor shall restore the Work to its original condition at his own expense.

C. Interpretation of Drawings and Project Manual

1. Any discrepancies among Drawings, Project Manual, Drawings and Project Manual, or between Drawings and Project Manual shall be promptly brought to the attention of the Engineer for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Engineer during the bidding period or of any error on the Contractor's part.
2. The locations of switch, receptacle, light, motor, etc., outlets shown on Drawings are approximate. The Contractor shall use good judgment in placing the preceding to eliminate all interference with ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Engineer.

3. Check all door swings so that light switches are not located behind doors. Relocate switches as required, with Engineer's review.
4. All general trades and mechanical Drawings shall be checked by the Contractor before installing any outlets, power wiring, etc.
5. Equipment sizes and locations shown on the Drawings are estimated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements, including wire and conduit entrance locations, and install wire, conduit, disconnect switches, motor starters, overload heaters, circuit breakers, or other items of the correct size and locations for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Engineer.
6. The Contractor shall provide all wiring, including disconnect switches and starters for all electrically operated equipment shown on Drawings, specified or required, except that starters and/or disconnect switches need not be furnished where it is specifically noted that they are furnished with the equipment.
7. The Drawings show the general arrangement required for installation of equipment and materials. The Contractor shall follow these Drawings as closely as possible. Should conditions necessitate other arrangements, the Contractor shall prepare and submit drawings showing the changes to the Engineer for review before proceeding with the Work.
8. The Engineer reserves the right to make minor changes in the location of the installation of equipment and materials up to the time of roughing in at no extra cost to the Owner.
9. The Drawings do not show all offsets and do not detail every point at which unusual conditions of construction may require special attention. All additional fittings, conduits or specialties and other appurtenances necessary due to field conditions shall be provided by the Contractor.
10. In all cases where a device or part of the equipment is herein referred to in the singular, it is intended that such reference shall apply to as many such devices as are required to complete the installations.
11. Wherever in this Division 26 a Manufacturer is specified with the notation “or approved equal," the decision as to the material or equipment being "equal" shall be made by the Engineer, without exception, and this decision shall be accepted by the Contractor as final. Where the Contractor proposes to furnish equipment or material in accordance with the "or approved equal" notation, said equipment or materials shall be submitted to the Engineer for review in accordance with the requirements set forth in the "Substitutions" paragraph of the "Submittals" paragraph of this Section.

1.4 SUBMITTALS

A. Transmittal: Furnish manufacturer's product data, test reports, and materials certifications as required.
   1. Follow the procedures specified in Division 01 Section "Submittal Procedures" and in addition, the Contractor shall prepare and submit a complete submittal list to the Engineer. The submittal list shall include all submittal items covered in the Division 26 specification sections. In addition, the submittal list shall contain dates for all items to be submitted and shall accompany the first submittal. The submittal list shall be coordinated with the construction schedule and shall clearly show such coordination.
   2. Shop Drawings: Shop drawings shall be submitted to the Engineer for approval. Shop drawings shall identify the specific equipment and material being supplied, and all accessories, dimensions, descriptions, mounting and connection details, wiring diagrams,

elementary control diagrams, equipment interface diagrams, and any other information necessary to determine compliance with the plans and specifications. Fabrication and installation shall be in accordance with the approved shop drawings.

3. Permits and Easements: Submit copies of reports, permits, and easements necessary for installation, use, and operation.
4. Test Reports: Submit copies of reports of tests, inspections, and meter readings as specified. Tests, inspections, and meter readings shall be performed using the Contractor's temporary power source unless otherwise specified.

B. Additional copies may be required by individual sections of these specifications.

C. Coordination Drawings

1. Prepare coordination drawings in accordance with Division 01 section "Project Coordination; Bid Package Contracts" to a scale of 1/4 inch = 1 foot–0 inches or larger, detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:
    a. Submit conduit layout drawings showing all conduit sizes, the number and size of each conductor installed in each conduit, and the intended use for each conduit. Drawings should clearly delineate method of conduit installation and should include details of any special conduit support or mounting method. All wiring devices, lighting fixtures, and equipment supplying or requiring electrical power shall be located on the layout drawings. In addition, include the following:
        1) Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
        2) Exterior wall and foundation penetrations.
        3) Fire-rated wall and floor penetrations.
        4) Equipment connections and support details. Demonstrate evidence of dimensional coordination.
        5) Sizes and location of required concrete pads and bases.
    b. Prepare and submit point-to-point interconnection wiring diagrams. The diagrams shall identify all external interconnecting wiring associated with all new and modified existing equipment. The diagrams shall be developed for performance of the Work and to document terminations.
        1) The point-to-point interconnection wiring diagrams shall include:
            a) Wiring and conduit numbers
            b) Terminal strip numbers for each wire termination
            c) Color coding
            d) Raceway and boxes in which wiring is to be located
            e) Location and functional name of items to which wiring is connected.
        2) Use information obtained from approved submittals, record drawings, and field inspections as necessary to complete the diagrams.
    c. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
    d. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

e. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

D. Record Documents: Prepare record documents in accordance with the requirements in Division 01 Section "Closeout Procedures". In addition to the requirements specified in Division 1, indicate installed conditions for:
1. Raceway systems, size, contents, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

E. Operations and Maintenance Manuals
1. Prepare maintenance manuals in accordance with Division 01 Section "Closeout Procedures". Compile and assemble the operation and maintenance data of equipment specified in Division 26 into a separate set of vinyl-covered three-ring binders, tabulated and indexed for easy reference. Data shall clearly indicate all options and accessories.
2. In addition to the requirements specified in Division 1, include the following information for equipment items:
a. Manual index.
b. Manufacturers' descriptive literature.
c. Final signed submittal copy of shop drawings.
d. As-built drawings.
e. Spare parts and replacement parts lists.
f. Manufacturers' maintenance and service manuals.
g. Project-specific description of operation.
h. Wiring diagrams.
i. Manufacturers' guarantee and warranty.
j. Test results.
k. Motor list, including motor description, motor horsepower, motor voltage, fuse size, fuse type, and overload size.
l. Fuse list including fuse location, fuse size, fuse type, and load description.
m. Fixture ballast schedule.
n. Lamp schedule.
3. Materials for more than one item shall clearly indicate which item or items are included on the Project.
4. Shop Drawings which are folded and punched for insertion in the Manual shall be such that the Drawings can be unfolded without removing them from the Manual, and all information shall be legible.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.6 SPECIAL WARRANTY

A. Compile and assemble the warranties specified in Division 26 into a separate set of vinyl-covered three-ring binders, tabulated and indexed for easy reference.

B. Provide complete warranty information for each item. Information to include:
   1. Product or equipment list.
   2. Date of beginning of warranty or bond.
   3. Duration of warranty or bond.
   4. Names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.7 DEFINITIONS

A. Finished locations. The following are defined as finished locations:
   1. Areas with carpet or tile floors.
   2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
   3. Areas with tiled, plastered, or paneled walls.

B. Interior locations. The following are defined as interior locations:
   1. Any location within the boundaries of the foundation of any building.
   2. Any location within the superstructure of other structures not classified as buildings.

C. Wet locations. The following are defined as wet locations:
   1. All exterior locations.
   2. All interior locations below grade.
   3. All interior locations where wet materials are processed, pumped, transported, or stored.

D. Corrosive locations. The following are defined as corrosive locations.
   1. All locations with chemical feed/transfer equipment
   2. All locations with chemical storage tanks
   3. All locations where chemical storage drums are located.

E. Hazardous (classified) locations. The following are defined as hazardous (classified) locations.
   1. All hazardous (classified) locations and their hazard classification are shown.

1.8 FAULT CURRENT, COORDINATION, AND SELECTIVITY STUDY

A. The Contractor shall provide to the Engineer three copies of a written, detailed, documented selective power distribution system report showing fault currents available using log-log graphical representation. The report shall be stamped by a professional Electrical engineer registered in Ohio. The report shall be based upon data compiled by the Contractor from the actual equipment installed. The report must be submitted and approved prior to project closeout. At a minimum, the report shall contain the following:
   1. Overall system description and diagrams.
   2. System selectivity under fault and other overload conditions.
   3. Ground fault system operation and selectivity.
   4. Tabularized ratings and settings of protection devices verified by electrical testing to ensure coordination and selectivity. They shall include all:
      a. Momentary and interrupting ratings.
      b. Relays and shunt trip devices.
      c. Fuses.

d. Circuit breakers.

5. Conclusions and recommendations.

B. Calculated fault currents shall be provided at the secondary of each transformer, at each piece of service equipment, between service equipment and each motor control center, switchboard or switchgear and for at least one feeder/branch circuit for each motor control center, switchboard, or switchgear. They shall include:
1. Equipment and conductor damage curves.
2. Pick-up and time current characteristics.
3. Short circuit data.
4. Detailed description of test procedures.
5. Design calculations.

1.9 SCHEDULING

A. General: It is mandatory that the facility be maintained in operation during construction and that periods of shut-down due to "line changeovers, etc. are held to a minimum. These outages must be scheduled with and have the concurrence of the Engineer and the Owner. Further, it is mandatory that the completion of various stages of the electrical work coincide with the other phases of construction to maintain and permit operation of new installations as construction progresses.

1.10 COORDINATION WITH WORK OF OTHER TRADE CONTRACTORS

A. General
1. Coordinate all requirements of the Work of this Division with other Trade Contractors. Such requirements include, but are not limited to, locations, sizes, anchors, and similar items.
2. Provide all necessary information to other Trade Contractors for such coordination. Such information shall include conforming Shop Drawings, conforming Product Data, and all other required data.
3. This Contractor shall bear all costs for providing affected Work of related Trade Contractor(s) with no change to the Contract Sum or Date of Substantial Completion.

B. Foundations, Bases, Curbs, and Supports
1. Provide and coordinate all requirements for foundations, bases, curbs, and supports with the related Trade Contractor(s).
2. Provide required dimensions, templates, and all required information on anchors, sleeves, and cast-in-place accessories, including dimensions, to the related Trade Contractor(s).

C. Openings, Recesses, and Chases: Coordinate all requirements and locations for openings, recesses, and chases with the related Trade Contractor(s).

D. Final Connections: Coordinate with the related Trade Contractor(s) all requirements for roughing-in and final connections for equipment installed under this Division.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Rough-In
   1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
   2. Refer to equipment specifications in Divisions 02 through 40 for rough-in requirements.

B. Electrical Installations: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
   1. Coordinate electrical systems, equipment, and materials installation with other building components.
   2. Verify all dimensions by taking field measurements.
   3. Coordinate and provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
   4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete or supported from or on other structural components, as they are constructed.
   5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building and equipment which must be placed in service before further construction can take place.
   6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service and place each in proper operating order.
   8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that the work is shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer before final placement.
   9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
   10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
   11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
   12. Wiring for equipment furnished by other Contractors shall be provided as specified under the Electrical Contract based on the equipment rating and motor horsepower as specified in the Contract Documents. If the equipment provided by the General, and Mechanical Contractors has different rating or horsepower, the General and Mechanical Contractors shall provide for any necessary electrical changes to accommodate the equipment furnished at no change in contract price. This Contractor shall verify actual equipment nameplate electrical ratings (voltage, horsepower, amps, etc.) match the specified electrical system being supplied to the equipment. Any discrepancies shall be brought to the attention of the Engineer prior to equipment being connected.

3.2 LOAD BALANCING

A. It shall be the responsibility of the Contractor to balance the loads on the service system, all distribution systems, and all power equipment, so that the variation in amperes per phase readings shall not exceed 5% under normal operating conditions.

B. Special care shall be taken during load balancing to prevent reverse rotation of motors.

C. If, during load balancing, a load is shifted from one phase to another in a color-coded system, the Contractor shall paint or tape the ends of the wire at all outlet points with the proper color code for that phase. Failure to do so shall constitute justifiable grounds to require the Contractor to replace the entire circuit with the proper coded wire at no expense to the Owner or Engineer.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with the following requirements:
   1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
      a. Uncover work to provide for installation of ill timed work.
      b. Remove and replace defective work.
      c. Remove and replace work not conforming to requirements of the Contract Documents.
      d. Remove samples of installed work as specified for testing.
      e. Install equipment and materials in existing structures.
      f. Upon written instructions from the Engineer, uncover and restore work to provide for the Engineer observation of concealed work.
   2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new work. Existing electrical items not indicated to be reused are to be removed.
   3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
   4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
   5. Protection of Installed work. During cutting and patching operations, protect adjacent installations.
   6. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
      a. Refer to Division 1 section "References" for definition of experienced "Installer."
   7. The Contractor shall install his work in such a manner and at such times as shall require a minimum of cutting and patching of the building structure.
   8. Certain areas require this Contractor to remove, add to, or relocate portions of existing Work. It shall be this Contractor's responsibility to remove ceilings, portions of walls, etc., in a manner so that he may install new Work. This Contractor shall then patch, repair and/or replace ceilings, walls etc., to match existing conditions. The above applies to all areas not specifically indicated on Architectural Drawings as Work to be performed by General Trades Contractor(s).
   9. If the Contractor fails to do any required patching or repair any damage resulting from the installation of the electrical Work, such patching or repairing shall be done by the Owner and the cost shall be paid by the Contractor.

3.4 ELECTRICAL DEMOLITION

A. General

1. In general, the notation to remove a piece of equipment as indicated on the Drawings shall be interpreted to also include the removal of all electrical equipment, conduit, wires and appurtenances associated with the equipment. This includes, but is not limited to: all wires and conduit from the motor control center starter to the equipment; and all disconnects, remote switches and starters; all controls, alarms, conduit and instrumentation, both local and remote, and all supports, braces and hangers.
2. Electrical removals also consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panel boards, lighting fixtures, and miscellaneous electrical equipment all as shown, specified, or required to perform the Work.
3. All removals of electrical equipment and appurtenances shall be in complete conformance with the requirements of Division 26.
4. It is the Contractor's responsibility as part of this work to maintain all existing electrical systems including power, lighting, intercommunication and instrumentation in continuous, acceptable operation. It is possible that during the period of construction some wiring may be cut or damaged either accidentally or otherwise. The Contractor shall install and maintain any and all temporary wiring (as approved by the Owner) required to keep all electrical apparatus in acceptable operating condition.
5. As soon as possible, the Contractor shall reinstall cut or damaged circuits in their permanent locations.
6. Where any electrical system component is damaged during work on this project and replaced in accordance with this section, the replaced work shall meet all requirements specified in Division 26 even though the damaged components may not have met the requirements of Division 26 prior to being damaged.
7. Where existing electrically operated equipment is relocated, the power and control wiring and appurtenant devices shall be relocated to accommodate same. Installations and materials shall conform to requirements specified in Division 26.
8. Electrical equipment, conduit, wire, and fixtures shall be relocated as necessary to accommodate installation of new and relocated electrically operated equipment and to accommodate structural alterations to existing facilities such as floors, walls, entrance ways, ducting, process equipment, and piping.
9. All equipment and major lengths of wiring retired and removed shall remain the property of the Owner unless shown or directed otherwise and shall be placed in storage on the site by the Contractor where ordered.
10. Existing Conduit Location
    a. In existing structures at this project, there is electrical conduit embedded in concrete. It shall be the responsibility of the Contractor, under this section, to attempt to locate and mark the existence of any conduit embedded in areas where, as part of this Contract, the concrete is to be drilled or cut into for any purpose.
    b. Contractor shall use every available means possible to attempt to locate existing conduit. Whenever a hole is to be cut into an existing slab, wall, or other structural concrete, that area shall be X-rayed prior to drilling to show the locations of conduits and resteel.

B. Electrical Equipment and Fixtures

1. Remove existing electrical equipment and fixtures where shown or required with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to keep the integrity of the grounding systems.

C. Switchboards
   1. Remove and modify distribution switchboards as shown.
   2. Disconnect and dismantle switchboards that are to be removed and dispose of all components off the site.
   3. Remove circuit breakers and other control equipment that will no longer be used from modified switchboards unless otherwise shown or specified.
   4. Cut square all new openings into the modified switchboard panels and dress smooth to the dimensions required for the installation of the new equipment.

D. Motors
   1. Disconnect and remove motors where shown or specified.
   2. Remove from the site motors not designated to remain the property of the Owner.
   3. Store in an enclosed, heated storage area motors or other electrical gear designated for reuse.

E. Conduit and Wire
   1. Remove conduits and wires where shown, or associated with equipment being removed.
   2. Cut abandoned conduits in floor or ceiling slabs, or in walls, flush with the slab or wall at the point of entrance. Plug the conduit suitably and repair the area in a flush, smooth, approved manner.
   3. Disassemble and remove from the site exposed conduits and their supports.
   4. Repair all areas of work to prevent rust spots on exposed surfaces.
   5. Dispose of all removed wire, conduits, supports, and appurtenances.

F. Underground Ducts
   1. Remove wiring in the underground duct system where shown or otherwise required.
   2. Verify the function of all wiring before disconnecting and removing it.
   3. Plug ducts which are not to be reused, where they enter buildings and make watertight.

G. Direct-Burial Cable
   1. Abandon direct-burial cable where shown.
   2. Disconnect such cable at both ends of the run.
   3. Cut back the cable to the point of entrance of a building or structure.
   4. Patch and make watertight all openings in buildings for entrance of abandoned direct-burial cable.

H. Overhead Wiring
   1. Abandon poles and overhead wiring as shown and specified.
   2. Existing substation and poles owned by the local electric utility company will be removed by the local electric utility company.
   3. Remove completely from the site abandoned poles not owned by the local electric utility company.
   4. Perform this work after the new service has been completed and energized, and in accordance with the approved schedule.

5. Make all the necessary arrangements with the local electric utility company for the removal of their transformers and metering equipment after the new electrical system has been installed and energized.

I. Lighting Fixtures
   1. Carefully remove and relocate lighting fixtures as shown on the Drawings.
   2. Remove fixtures from the project site that are not shown to be relocated.

J. Panelboards
   1. Remove panelboards where shown and dispose of off the project site.
   2. Perform all cutting and patching necessary for the removal and replacement of panelboards.

K. Miscellaneous Electrical Equipment
   1. Remove wall switches, receptacles, starters, and other miscellaneous electrical equipment as required and dispose of off the project site.
   2. Remove all equipment with care so as to minimize damage to architectural and structural members. Repair any damage incurred as herein specified.

3.5 CLEANING

A. General: When all work is completed and has been tested and accepted by the Engineer, the Contractor shall clean all light fixtures, equipment, and exposed surfaces that have been directly affected by this work. The Contractor, insofar as the work is concerned, shall at all times keep the premises in a neat and orderly condition and at the completion of the work shall properly clean up and remove any excess materials from the site.

END OF SECTION 26 0505

SECTION 26 0510

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to provide basic electrical materials in accordance with the plans and as specified herein.

B. This section includes limited scope general construction materials and methods for application with electrical installations as follows:
   1. Excavation for underground utilities and services, including underground raceways, vaults, and equipment.
   2. Miscellaneous metals for support of electrical materials and equipment.
   3. Nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
   4. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
   5. Concrete used for the following:
      a. Housekeeping pads.
      b. Pipe supports.
      c. Filling in boxouts in floor slabs, after conduit installation.
      d. Pole foundations.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with basic electrical materials in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein. Where provisions of the pertinent codes and standards conflict with this specification, the more stringent provision shall govern.
   1. American Institute of Steel Construction (AISC) "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings."
   2. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
   3. National Electrical Code (NEC).

B. Qualifications
   1. Installer Qualifications. Engage an experienced Installer for the installation and application of joint sealers.
   2. Qualify welding processes and welding operators in accordance with American Welding Society (AWS) D1.1 "Structural Welding Code -Steel."
      a. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submit the following in accordance with Conditions of Contract and Division 01 specification sections.
   1. Product data for joint sealers.
   2. Shop drawings detailing fabrication and installation for metal fabrications and wood supports and anchorage for electrical materials and equipment.
   3. Samples of joint sealer, consisting of strips of actual products showing full range of colors available for each product.
   4. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this section.

1.5 JOB CONDITIONS

A. Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle joint sealer materials in compliance with the manufacturer's recommendations to prevent their deterioration and damage.

1.7 DEFINITIONS

A. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation at the direction of the Engineer until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

B. Subbase as used in this section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

C. Subgrade as used in this section refers to the compacted soil immediately below the slab or pavement system.

D. Unauthorized excavation as used in this section consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil Materials: Provide soil materials as specified in Division 31 - Earthwork.

B. Miscellaneous Metals and Reinforcing Materials
   1. Provide steel plates, shapes, bars, and bar grating conforming to ASTM A 36.
   2. Provide cold-formed steel tubing conforming to ASTM A 500.
   3. Provide hot-rolled steel tubing conforming to ASTM A 501.
   4. Provide steel pipe conforming to ASTM A 53, Schedule 40, welded.
   5. Provide non-shrink, non-metallic grout which is pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout, recommended for interior and exterior applications.
   6. Provide fasteners which are zinc-coated, type, grade, and class as required.
   7. Provide deformed reinforcing bars conforming to ASTM A615, Grade 40 or 60, unless otherwise indicated.
   8. Provide reinforcing materials with size and placement as shown on the plans.
   9. Provide welded wire fabric conforming to ASTM A185.

C. Miscellaneous Lumber
   1. Provide framing materials that are Standard Grade, light framing size lumber of any species. Number 3 Common or Standard Grade boards complying with West Coast Lumber Inspection Bureau (WCLIB) or American Wood Preservers Association (AWPA) rules, or Number 3 boards complying with Southern Pine Inspection Bureau (SPIB) rules. Lumber shall be preservative treated in accordance with AWPA LP-2, and kiln dried to a moisture content of not more than 19 percent.
   2. Provide construction panels which are plywood panels; American Plywood Association (APA) C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inch.

D. Joint Sealers
   1. Provide joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
   2. Provide colors as selected by the Engineer from manufacturer's standard colors.
   3. Provide the following types of elastomeric joint sealers:
      a. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates, formulated with fungicide, intended for sealing interior joints with non-porous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
   4. Provide fire-resistant watertight joint sealers which are two-part, foamed-in-place, silicone sealant formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by UL, or other testing and inspection agency acceptable to authorities having jurisdiction. Material shall be a closed-cell, non-adhering material.

E. Concrete: Provide concrete as specified in Division 03 - Concrete.

2.2 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   1. One Part, Mildew-Resistant, Silicone Sealant
      a. "Dow Corning 786," Dow Corning Corp.

b. "SCS 1702 Sanitary," General Electric Co.
c. "863 #345 White," Pecora Corp.
d. "Proglaze White," Tremco Corp.
e. "OmniPlus," Sonneborn Building Products Div.

2. Fire Resistant Joint Sealers
   a. "Dow Corning Fire Stop Foam," Dow Corning Corp.
   b. "Pensil 851," General Electric Co.

PART 3 - EXECUTION

3.1 COORDINATION

A. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Field-verify all locations and dimensions to ensure that the equipment will be properly located, readily accessible, and installed in accordance with all pertinent codes and regulations, the contract documents, and the referenced standards.

C. The work shall be carefully laid out in advance, and where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary for proper installation, this work shall be carefully done, and any drainage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.

D. In the event any discrepancies are discovered, immediately notify the Engineer in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 PREPARATION

A. Preparation for Joint Sealers
   1. Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
   2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.3 EXCAVATION

A. Comply with the applicable requirements of Division 31 - Sitework.

B. For the excavation of underground vaults and electrical structures conform to elevations and dimensions shown within a tolerance of +0.10 foot and extending a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
   1. Excavate, by hand, area within drip line or large trees. Protect the root system from drainage and drying out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
   2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement or precast concrete is placed.

C. Excavate trenches for electrical installation as follows:
   1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
   2. Excavate trenches to depth indicated or required.
   3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
   4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.

D. Backfill excavations as promptly as work permits, but not until completion of the following:
   1. Inspection, testing, approval, and locations of underground utilities have been recorded.
   2. Removal of concrete formwork.
   3. Removal of shoring and bracing, and backfilling of voids.
   4. Removal of trash and debris.

E. Where subsidence occurs at electrical installation excavation during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.4 INSTALLATION

A. Erection of Metal Supports and Anchorage
   1. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
   2. Provide field welding which complies with AWS "Structural Welding Code."

B. Erection of Wood Supports and Anchorage
   1. Cut, fit, and place nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
   2. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
   3. Attach to substrates as required to support applied loads.

C. Application of Joint Sealers
   1. Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
   2. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
   3. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
   4. Install firestopping sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire stops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency. Use dams to obtain proper sealing.

D. Installation of Housekeeping Pads

1. Strength, spacing, and placement of equipment housekeeping pads. Provide a housekeeping pad for all floor-mounted equipment, unless noted otherwise. Fabricate pad as follows:
    a. Coordinate size of housekeeping pad with actual equipment provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported equipment.
    b. Form concrete pads with framing lumber treated with form release compounds. Provide 1 inch chamfer on top edge and corners of pad.
    c. Install reinforcing bars and place anchor bolts and sleeves to facilitate securing equipment.

END OF SECTION 26 0510

SECTION 26 0519

WIRES, CABLES, AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install wires, cables, and connectors in accordance with the plans and as specified herein.

B. Miscellaneous: This section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with wires, cables, and connectors in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. National Fire Protection Association (NFPA) 70, National Electrical Code (NEC).
   2. Underwriters' Laboratories, Inc. (UL) Compliance. Provide components which are listed and labeled by UL under the following standards.
      a. UL Standard 83Thermoplastic Insulated Wires and Cables.
      b. UL Standard 486AWire Connectors and Soldering Lugs for Use with Copper Conductors.
      c. UL Standard 854 Service Entrance Cable.
   3. National Electrical Manufacturers Association/lnsulated Cable Engineers Association (NEMA/ICEA) Compliance. Provide components which comply with the following standards:
      a. WC-5 Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      b. WC-7 Cross-Linked Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      c. WC-8 Ethylene Propylene Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   4. Institute of Electrical and Electronic Engineers (IEEE) Compliance. Provide components which comply with the following standards:
      a. Standard 82 Test Procedure for Impulse Voltage Tests on Insulated Conductors.

B. Regulatory Requirements: Comply with provisions of the following code and conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submittals: Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for electrical wires, cables, and connectors.
   2. Product data for Megger insulation testing instrument.
   3. Report sheets for Megger testing.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable properly packaged in factory-fabricated-type containers, or wound on NEMA specified type wire and cable reels.

B. Store wire and cable in clean, dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing, and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wires and Cables
   1. Provide electrical wires and cables of manufacturer's standard materials as indicated by published product information designed and constructed as recommended by manufacturer for a complete installation, and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20 deg C (68 deg F).
   2. Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following UL types those wires with construction features which fulfill project requirements:
      a. Provide Type RHW for dry and wet locations, maximum operating temperature 75 deg C (167 deg F). Insulation, moisture and heat-resistant cross-linked polyethylene; outer covering, moisture-resistant, flame-retardant, non-metallic covering; conductor, annealed copper, Class B stranding.
      b. Provide Type XHHW for dry locations, maximum operating temperature 90 deg C (194 deg F). Insulation, flame-retardant, cross-linked polyethylene; conductor, annealed copper, Class B stranding.
      c. Provide Type THW for dry and wet locations; maximum operating temperature 75 deg C (167 deg F). Insulation, moisture and heat-resistant, flame-retardant thermoplastic; conductor, annealed copper, Class B stranding.

d. Provide Type THWN/THHN for dry and wet locations; maximum operating temperature 75 deg C (167 deg F). Insulation, moisture and heat-resistant, flame-retardant thermoplastic; conductor, annealed copper, Class C stranding.
e. Provide Type MTW for dry locations, maximum operating temperature 90 deg C (167 deg F). Insulation, flame-retardant, moisture, heat and oil-resistant thermoplastic, Class C stranding.

3. VFD Cable
   a. General
      1) UL 1277, UL 1581.
      2) Flexible multi-conductor motor supply cable.
      3) 100% Overall foil or tape shield, drain wire, and PVC jacket.
      4) Bare uncoated copper ground conductor.
      5) Rated 1000VAC / 2000VAC Peak.
   b. Conductors
      1) ASTM B8/B33.
      2) Tinned copper conductors.
      3) Class C stranding.
   c. Insulation: Flame-retardant, moisture-resistant thermoset (XLP) insulation.
   d. Conductor Types: Type XHHW conductors, 1000-Volt, 90 deg C, wet or dry locations, UL 44.
4. Provide color coding for phase identification in accordance with requirements in Division 26 Section "Electrical Identification".

B. Connectors and Terminals
1. General: Provide UL-type factory-fabricated metal connectors and terminals of sizes, ampacity ratings, materials, types, and classes indicated.
2. Twist-on Connectors: Conforming to UL 486 C, consisting of a tapered spring with insulated outer covering.
3. Compression Connectors: Tin-plated copper. Configuration shall be tee, in-line, etc., as required.
4. Terminals: Tin-plated copper, compression locking fork tongue with insulated barrel.
5. Compression Lugs: Tin-plated copper, standard barrel, one-hole or two-hole as required.
6. Heat-Shrink Insulation: Heat-shrinkable polyolefin with an internally applied adhesive watertight sealant.
7. Motor Connection Kit: Consisting of compression lugs bolted together, cloth tape cover, and heat-shrink insulation.
8. Splice Kit: Consisting of compression connector and heat-shrink insulation.

C. Wire and Cable Accessories
1. Tapes and Insulating Materials
   a. Designed for use as electrical insulating tape.
   b. Plastic Tape: Vinyl, 7 mil, 3/4-inch wide, -15 to 100 deg C, UL 510.
   c. Rubber Tapes: Self-fusing, corona-resistant, compatible with specified insulations, minimum dielectric strength of 800 V per mil, 0 to 90 ^{0}C.
   d. Arc-Proofing: Thirty mil, up to 3-inches wide, rated for a 200-amp arc for 30 seconds.
   e. Heat Shrink Insulation: Heat shrinkable polyolefin, internal adhesive sealant, UL 486D.
2. Hardware
   a. General: Carbon steel, cadmium plated.
   b. Bolts: ASTM 449, hex-head, SAE Grade 5, UNC, Class 2B threads.

c. Nuts: ASME B18.2.2, hexagon, SAE Grade 5, UNC, Class 2B threads.
d. Flat Washers: ASME B18.22.1; type A plain, wide-series.
e. Compression (Belleville) Washers: Conical type washer, 0.0005-in.-thick.

3. Wire-Pulling Lubricant
a. Listed by Underwriters Laboratories.
b. Biodegradable, non-flammable, and non-toxic.
c. Solid residue of not more than 1.5 percent and a viscosity of at least 50,000 C.P.S.
d. Compatible with conductor insulation per IEEE 1210.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Wire and Cable
a. American Insulated Wire Corp.
b. Brintec Corp.
c. Carol Cable Co., Inc.
d. Senator Wire and Cable Co.
e. Southwire Company.

2. Connectors and Terminals for Wires and Cable Conductors
a. AMP.
b. Burndy Corporation.
c. Ideal Industries, Inc.
d. 3M Company.
e. O-Z/Gedney Co.
f. Raychem.
g. Thomas and Betts Corp.

3. Tapes and Insulating Materials
a. Okonite Company
b. Plymouth Rubber Company
c. Raychem
d. 3M Company
e. Tyco Corporation, AMP products

4. Wire-Pulling Lubricant
a. Polywater J.
b. High Performance Cable Lubricant.
c. Ideal.
d. Aqua-Jel 2.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION

A. Uses Permitted

1. Install UL Type USE cable for all conductors provided between utility transformers and service entrance rated equipment.
2. Install UL Type RHW or XHHW cable for power feeders, motor branch circuits, panelboard feeder circuits, and below grade or exterior control and metering circuits.
3. Install UL Type THWN/THHN, THW, or XHHW wiring in conduit, for branch circuits for lighting, receptacles, and interior control and metering circuits.

4. Install UL Type MTW wiring interior to instrument and control panels. Conductors shall be stranded with at least 19 strands in the conductor.
5. Install VFD Cable for all branch circuits of VFD controlled equipment.

B. Install electrical cables, wires, and connectors in compliance with NEC.

C. Coordinate cable installation with other work.

D. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL-listed pulling compound or lubricant, where necessary.

E. Use pulling means, including fish tape, cable, rope, and basketweave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

F. Conceal all cable in finished spaces.

G. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible.

H. Power conductors shall be No. 12 AWG minimum. Control conductors may be No. 14 AWG where circuit amperes and the NEC allow and when length does not pose a voltage drop problem.

I. Conductors shall be sized such that voltage drop does not exceed 3% for branch circuits or 5% for feeder/branch circuit combination.

J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

K. Provide connectors, splices, or lugs as required for all oversized conductors due to voltage drop.

3.2 CONNECTOR, TERMINAL, AND SPLICE INSTALLATION

A. Uses Permitted
1. Install twist-on connectors for lighting, communication, and receptacle branch circuits and utilization equipment only in size No. 8 AWG and smaller and only in finished areas.
2. Install forked-tongue terminals on control and metering conductors which connect to terminal blocks.
3. Install motor connection kits on all polyphase induction motors.
4. Install compression connectors and lugs for all other connections.

B. Use splice and tap connectors which are compatible with conductor material.

C. Install all compression connectors, splices, and lugs with a racheting tool which will not release until proper compression is achieved.

D. Install splices which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.

E. Service entrance conductors shall be installed without splices. Electrical equipment feeders shall be spliced only where shown or specifically approved. Control and metering conductors shall be installed without splices.

F. All splices shall be made only by specific permission of the A/E, and then only in manholes or pullboxes, and shall be sealed watertight with a heat-shrink insulation.

G. Tighten electrical connectors and terminals in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

3.3 FIELD QUALITY CONTROL

A. The Contractor shall test each electrical circuit after permanent cables are in place with terminators installed, but before cable or wire is connected to equipment or devices to demonstrate that each circuit is free from improper grounds and short circuits.

B. The Contractor shall test by Megger Test, the insulation resistance between phases and from each phase to ground for each of the following feeder and motor branch circuits:
1. Motor Control Center.
2. Panelboard.
3. Switchboards.
4. Switchgear.
5. Motors.

C. The Megger Testing shall be witnessed by the A/E. The A/E shall be notified at least 48 hours in advance of testing.

D. Measure the insulation resistance at 500 volts dc with a hand-cranked or motor-driven "Megger" insulation testing instrument. Battery-operated test instruments are not permitted. All test instruments are to be provided by the Contractor.

E. If any insulation resistance measures less than 50 megohms, the cable shall be considered faulty with the cable failing the insulation test. In moist environments, bag the ends of the cable to prevent a faulty Megger test.

F. Any cable which fails the insulation tests or which fails when tested under full load conditions shall be replaced with new cable for the full length and retested. Corrective action and repeated tests shall be accomplished at the Contractor's own expense.

G. Maintain testing report sheets identifying each cable tested, what each feeder or motor branch circuit will be connected to, and the level of insulation resistance measured. Test reports shall be signed by the tester, initialed by the A/E and sent to the A/E within 48 hours.

END OF SECTION 26 0519

SECTION 26 0523

SIGNAL AND COMMUNICATION CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this section.

B. Related Sections: The following sections contain requirements that relate to this section:
   1. Division 26 Section “Basic Electrical Requirements”.
   2. Division 26 Section “Basic Electrical Materials and Methods”.
   3. Division 26 Section “Wires and Cables”.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install communication and signal cables in accordance with the plans and as specified herein.

B. Cables and Accessories: This section includes cables and connectors designed for and used in communication, control, data, and signal circuits.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

B. Connected Equipment Manufacturer Approval: Where cables specified in this section are used to provide signal paths for systems specified in other sections of these specifications or for systems furnished under other contracts, obtain review of the cable characteristics and approval for use with the connected system equipment by the connected equipment manufacturers.

C. Electrical Component Standard: Provide work complying with applicable requirements of National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."

D. Toxicity: Comply with applicable codes and regulations regarding toxicity of combustion products of materials used in communication and signal cables.

E. National Electrical Manufacturer's Association/Insulated Cable Engineers Association (NEMA/ICEA) Compliance: Comply with NEMA/ICEA Standard Publication WC 5, "Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy"; WC 30, "Color Coding of Wires and Cables," pertaining to signal transmission cable; and WC 41, "Coaxial Communication Cable."

F. American Society for Testing and Materials (ASTM) Compliance: Comply with applicable requirements of ASTM B 1, B 2, B 3, B 8, B 33, D 2219, and D 2220. Provide copper conductors with conductivity of not less than 98 percent at 20 deg C (68 deg F).

G. Underwriters' Laboratories, Inc. (UL) Compliance: Comply with applicable requirements of UL Standard 83, "Thermoplastic Wires and Cables"; UL 486 A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors"; and UL 910, "Test Method for Fire and Smoke Characteristics of Cables Used in Air Handling Spaces." Provide products that are UL listed and labeled.

H. Electronic Industries Association (EIA) Compliance: Comply with EIA Standards EIA-230, "Color Marking of Thermoplastic Wire," EIA-258, "Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms," and TIA/EIA-568A, "Commercial Building Telecommunications Cabling Standard."

I. MIL-SPEC Compliance: Comply with MIL-C-3093, "Telephone Cable; Inside Distribution Wiring," MIL-C-55021, "Twisted-Pair and Triplet Cables; Hookups General Specifications," MIL-C-17/28, "Radio Frequency Flexible Coaxial Cables, 50 Ohms," and MIL-C-17/29, "Radio Frequency Flexible Coaxial Cables, 75 Ohms."

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and material certifications as required.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable properly packaged in factory fabricated type containers, or wound on NEMA specified type wire and cable reels.

B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing, and tearing wire, cable insulation, and sheathing. Ensure that dielectric resistance and characteristic impedance integrity of the cable are maintained.

PART 2 - PRODUCTS

2.1 SHIELDED TWISTED PAIR CABLES

A. 600 Volt Rated Shielded Twisted Pair or Triplet Cables: Shielded twisted pair or triplet cable, 16 AWG stranded tinned copper conductors, polyethylene insulation, aluminum tape shield, 18 AWG tinned copper drain wire, UV stabilized PVC jacket, 100 percent shield coverage. Suitable for direct burial. Multiple pair cables shall have an overall shield and an overall PVC jacket.

2.2 CONTROL NETWORK CABLES

A. Ethernet: Four pair, unshielded, Category 6, 24 AWG, stranded copper with PVC insulation and PVC jacket. Cable shall be UL listed.

B. Fiber-Optic:

1. Multimode graded index, tight-buffered, optical glass fiber cores cable:
    a. Compatible with LED-based transmission system and suitable for fiber optic Ethernet LAN standards including point-to-point Fiber Optic Inter-Repeater Link (FOIRL) network, and ANSI standard Fiber Distribution Data Interface (FDDI) networks.
    b. Do not use cable with plastic fiber core construction.
    c. The number of cables and the number of fibers in each cable shall be as specified herein and as shown on the Drawings.
    d. Splitter Kits: The cable shall be provided with the necessary number of splitter kits to accommodate the number of terminations shown for each interconnection box on the Drawings.
    e. Cable shall be assembled with inner strength members, polyester core separator tape, Aramid yarn or similar strength members.
    f. Jackets: Inner PVC jacket with rip cord, and polyethylene outer jacket rip cord. Provide a cable outer jacket that is UV inhibited, fungus resistant and flame retardant.
    g. Attenuation losses: Shall be 3.5 dB/km or less at a wavelength of 850 nm and 1.0 dB/km or less at a wavelength of 1300 nm.
    h. Bandwidth: Minimum bandwidth shall be 160 MHz-km at 850 nm and 500 MHz-km at 1300 nm.
    i. Provide cable unaffected by continuous or intermittent submergence in water, damage from lightning strikes. Shall be resistant to fuel, petro-chemicals and other caustic or noxious materials.
    j. Cable shall be suitable for indoor and outdoor use conduit installation.
    k. Provide continuous inter- and intra- building installation, closet to closet, suitable for passing through inside conduit locations directly from outside conduit.
    l. Cable shall be UL listed as type OFN per NEC 770-51 and NEC 770-53.
    m. Cable specifications are as follows:
        1) Fiber Size: 62.5 micron/125 micron (core/cladding)
        2) Fiber Count: 12 fibers
        3) Nominal Cable Diameter: 0.256 inches
        4) Nominal Cable Weight: 33 pounds per 1000 ft
        5) Crush Resistance: 500 pounds per inch
        6) Maximum Tensile Load: 600 pounds (installation)
        7) Maximum Tensile Load: 135 pounds (in-service)
        8) Minimum Bend Radius: 5.1 inches (installation)
        9) Minimum Bend Radius: 2.6 inches (in-service)
        10) Operating Temperature: -40 to 80degC (core/cadding)
        11) Guaranteed to achieve 300/550 meters at 850/1300 nm for Gigabit Ethernet (IEEE 802.3z) standard-compliant links.
2. Single mode, tight-buffered, optical glass fiber cores cable:
    a. Compatible with laser-based transmission system and suitable for fiber optic Ethernet LAN standards including point-to-point Fiber Optic Inter-Repeater Link (FOIRL) network, and ANSI standard Fiber Distribution Data Interface (FDDI) networks.
    b. Do not use cable with plastic fiber core construction.
    c. The number of cables and the number of fibers in each cable shall be as specified herein and as shown on the Drawings.

d. Splitter Kits: The cable shall be provided with the necessary number of splitter kits to accommodate the number of terminations shown for each interconnection box on the Drawings.
e. Cable shall be assembled with inner strength members, polyester core separator tape, Aramid yarn or similar strength members.
f. Jackets: Inner PVC jacket with rip cord, and polyethylene outer jacket rip cord. Provide a cable outer jacket that is UV inhibited, fungus resistant and flame retardant.
g. Attenuation losses: Shall be 0.5 dB/km or less at a wavelength of 1310 nm and 0.4 dB/km or less at a wavelength of 1550 nm.
h. Provide cable unaffected by continuous or intermittent submergence in water, damage from lightning strikes.
i. Cable shall be suitable for indoor and outdoor use conduit installation.
j. Cable shall be UL listed as type OFN per NEC 770-51 and NEC 770-53.
k. Cable specifications are as follows:
    1) Fiber Size: 8.3 micron/125 micron (core/cladding)
    2) Fiber Count: 12 fibers
    3) Nominal Cable Diameter: 0.256 inches
    4) Nominal Cable Weight: 33 pounds per 1000 ft
    5) Crush Resistance: 500 pounds per inch
    6) Maximum Tensile Load: 600 pounds (installation)
    7) Maximum Tensile Load: 135 pounds (in-service)
    8) Minimum Bend Radius: 5.1 inches (installation)
    9) Minimum Bend Radius: 2.6 inches (in-service)
    10) Operating Temperature: -40 to 80degC (core/cadding)

2.3 CONNECTORS AND TERMINALS

A. Shielded Twisted Pair:
1. Provide terminals as specified in Division 26 Section "Wires, Cables, and Connectors."

B. Ethernet Cable:
1. Provide RJ45 plug at each end.

C. Fiber-Optic Cable:
1. Furnish connect micron core/claddings and components and use specific tools and methods as recommended by the connector manufacturer to form a complete connector system.
2. Provide fiber optic SC simplex connectors; multimode and single mode versions to match cable type. Connectors shall be polymer body with a precision zirconia ferrules.
    a. Connector Specifications
        1) Insertion Loss: 0.15/0.30 dB (typical/maximum)
        2) Durability Delta: 0.1 dB (1000 matings)
        3) Operating Temperature: -40 to +80°C
        4) Cable Retention: 40 pounds
3. Splicing/Splitting
    a. Contractor shall field splice each fiber to a pigtail cable at the termination enclosures. All splices shall be made by the fusion process and shall have a splice loss no greater than 0.35 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each splice. Splice testing shall

be witnessed by the Owner's project representative. Prior to stripping the cable, Contractor shall record the cable length from the cable jacket. This length shall be documented and included in the test documentation.

2.4 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering control/signal cabling products that may be incorporated in the work include but are not limited to the following:

B. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   1. Cables.
      a. Alpha Communications.
      b. American Insulated Wire Corp.
      c. AT&T Network Systems.
      d. Belden Div; Cooper Industries.
      e. Berk-Tek Company.
      f. Cable Continental Cables Co.
      g. Furon Dekoron Division.
      h. Guardian Products Division, General Cable Corporation.
      i. Mohawk Wire & Cable Corp.
      j. Phelps Dodge Cable and Wire Co.
      k. Pirelli Cable Corp.
   2. Connectors.
      a. Thomas & Betts Corporation.
      b. 3M Company.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which communication and signal cables are to be installed. Notify Engineer/Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer/Architect.

3.2 COORDINATION

A. Coordinate with other work, including wires/cables, boxes, and raceways, as necessary to interface installations of communication and signal cables with other work.

3.3 APPLICATIONS

A. Use 300 volt rated single or multiple pair signal cables for all analog dc signals (4-20 mA, 1-5 volt, etc.).

B. Use Ethernet cable for all telephone lines.

C. Use Ethernet cable for all control network connections, unless noted otherwise on the Drawings.

3.4 INSTALLATION

A. General: Install communication and signal cables in accordance with manufacturer's written instructions, in compliance with NEC, and in accordance with standard industry practice.

B. Coordinate installation with other work.

C. Install communication and signal cables without damaging conductors, shield, or jacket. Do not either in handling or installation bend cable to smaller radii than minimum recommended by manufacturer. Ensure that medium manufacturer's recommended pulling tensions are not exceeded. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cable or raceway.

D. Install all cables in conduit.

E. Splices are allowed only at indicated splice points. Where splices are indicated, use splice and tap connectors that are compatible with media material.

F. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published instructions for torque tightening values.

G. Cable Terminations: Terminate cables on numbered terminal blocks where cable terminations are made on backboards and in cabinets and outlet boxes.

H. Wiring at Backboards and Cabinets: Install conductors parallel to and at right angles to walls. Bundle, lace, and train the conductors to terminal points with no excess. Use wire distribution spools at points where cables are fanned or conductors turned. Label each terminal.

I. Conductor Terminations: Terminate conductors of cables on terminal blocks using tools recommended by terminal block manufacturer.

3.5 GROUNDING

A. Provide equipment grounding connections for telephone systems as indicated. Tighten connections to comply with tightening torque specified in UL Standard 486A to ensure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL

A. Copper Cabling.
   1. Provide at least 10-days notice in writing when the cabling network is ready for final acceptance testing.
   2. All testing shall be in the presence of the Owner’s project representative.
   3. Test each UTP cable in accordance with EIA/TIA-568B guidelines to Category 6 performance testing parameters.

4. Factory test results for patch cables will be acceptable where the factory testing parameters clearly meet or exceed the EIA/TIA-568B guidelines.
5. Electronic test results shall be provided to the Owner's project representative for review.
6. Any cable that fails to meet its specified performance characteristics shall be replaced with a new cable and retested.

B. Fiber-Optic Cabling.
1. Test each fiber strand in accordance with manufacturer's published test procedures.
2. Test each fiber strand at dual wavelengths.
   a. 850 nm and 1300 nm for multimode.
3. Cable performance shall meet or exceed the following performance criteria: multimode - 3.75 dB/km at 850 nm and 1.5 dB/km at 1310 nm.
4. Test each fiber strand with an optical time domain reflectometer (OTDR).
5. The OTDR anomaly resolution shall be within one foot in runs up to 1,000 feet in length.
6. Test all cable segments and patch cords for faulty connectors, splices, and terminations and for the integrity of the cable and its component parts at 850 and 1300 nm multimode.
7. Each connector shall test to a maximum of .1 dB loss.
8. Replace connectors on cables that exceed the .1dB limit and retest.
9. Replace connectors and retest new materials until satisfactory performance is achieved.
10. Use a time domain reflectometer to record transmission characteristics, waveform, and performance of all fiber strands.
11. Use an optical loss test set (OLTS) to measure the optical transmission loss (attenuation) on each optical fiber strand in the system.
12. Electronic test results shall be provided to the Owner's project representative for review.

END OF SECTION 26 0523

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SECTION 26 0526

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install grounding materials in accordance with the plans and as specified herein.

B. Grounding: This section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this section may be supplemented in other sections of these Specifications.

C. Applications of electrical grounding and bonding work in this section include the following:
1. Underground metal piping.
2. Underground metal and steel reinforced concrete structures.
3. Electrical power systems.
4. Grounding electrodes.
5. Counterpoise loops.
6. Separately derived systems.
7. Raceways.
8. Service equipment.
9. Enclosures.
10. Equipment.
11. Lighting standards.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work to furnish and install grounding in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and National Electrical Code (NEC) as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment. Use of conduit system for ground conductor shall not be allowed.
2. Underwriters' Laboratories, Inc. (UL) Compliance: Comply with applicable requirements of UL Standards Nos. 467, "Grounding and Bonding Equipment", and 869 "Reference Standard for Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors". Provide grounding and bonding products which are UL listed and labeled for their intended usage.

3. Institute of Electrical and Electronic Engineers (IEEE) Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submittals: Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for ground rods, connectors and connection materials, and grounding fittings. Field testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
   2. Report of field tests and observations certified by the testing organization.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver ground wire properly packaged in factory fabricated type containers, or wound on NEMA specified type wire reels.

B. Handle grounding wire carefully to avoid abrading, puncturing and tearing wire insulation. Ensure that dielectric resistance of the cable is maintained

C. Store grounding materials and ground wire in clean dry space in original containers. Protect products from weather damaging fumes, construction debris, and traffic.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Grounding and Bonding Products
   1. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
   2. Conductor Materials: Copper

B. Wire and Cable Conductors
   1. General: Comply with Division 26 Section “Wires, Cables and Connectors”.
   2. Equipment Grounding Conductor
      a. Minimum ground wire size for power circuits shall be No. 12 AWG, except where otherwise noted. Wire size No. 8 AWG and larger shall be stranded, and all smaller wires shall be solid, except where otherwise noted.
      b. Minimum ground wire size for control circuits shall be No. 14 AWG, except where otherwise noted.
      c. All wire sizes shown on Plan Drawings, Details, and Sketches are based on insulated copper wire based on 60 deg C for circuits 125 amperes and less, and the use of 75 deg C for higher ampere rated circuits.
      d. Conductors for grounding system shall be soft or medium hard drawn, stranded, bare copper, except where otherwise noted.

3. All conductors buried in ground shall be bare.
4. Grounding Electrode Conductor: Stranded cable
5. Bare Copper Conductors: Conform to the following:
    a. Solid Conductors: ASTM B-3.
    b. Assembly of Stranded Conductors: ASTM B-8.
    c. Tinned Conductors: ASTM B-33.

C. Identification of Ground Conductors
1. Ground conductors shall have conductor identification.
2. Ground conductor identification shall be as called for in the National Electric Code, where covered.
3. Ground conductors larger than No. 6 AWG may be identified by taped color coding at all splices and terminations.
4. Ground conductors No. 6 AWG and smaller shall be color coded.
5. Ground conductor color coding shall be green throughout.
6. Wire markers made of paper tape shall not be used.

D. Miscellaneous Conductors
1. Ground Bus: Bare annealed copper bars of rectangular cross section with 98 percent conductivity, rigidly attach to structure.
2. Braided Bonding Jumpers: Copper tape, braided No. 30 gauge bare copper wire, terminated with copper ferrules.
3. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

E. Connector Products
1. General: Listed and labeled as grounding connectors for the materials used.
2. Pressure Connectors: High conductivity plated units.
3. Bolted Clamps: Heavy duty units listed for the application.
4. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

F. Grounding Electrodes
1. Ground Rods: Copper clad steel with high strength steel core and electrolytic grade copper outer sheath, molten welded to core.
    a. Size: 3/4 inch by 20 feet.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include the following:
1. Anixter Bros., Inc.
2. Bashlin Industries, Inc.
3. Buckingham Mfg. Co.
4. A.B. Chance Co.
5. Dossert Corp.
6. Engineered Products Co.
7. Erico Products, Inc.
8. Galvan Industries, Inc.
9. GB Electrical, Inc.
10. General Machine Products Co., Inc.

11. Hastings Fiber Glass Products, Inc.
12. Ideal Industries, Inc.
13. Kearney-National.
14. McGill Mfg.
15. O-Z/Gedney Co.
16. Raco, Inc.
17. Thomas & Betts Corp.
18. W.H. Salisbury & Co.
19. Utilco Co.

B. Exothermic Weld Connections
1. Cadweld.
2. Therm-O-Weld.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.
2. Ground Rods: Locate a minimum of one rod length from each other and at least the same distance from any other grounding electrode. Interconnect all ground rods with bare conductors buried at least 24 inches below grade. Connect bare cable ground conductors to ground rods by means of exothermic welds. Make these connections without damaging the copper coating or exposing the steel. Drive rods until tops are 2'-6" below finished floor or final grade except as otherwise indicated.
3. Metallic Water Service Pipe: Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground clamps. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings. Bond the ground conductor conduit to the conductor at each end.
4. Braided Type Bonding Jumpers: Install to connect ground clamps on meter piping to bypass meters electrically. Use elsewhere for flexible bonding and grounding connections.
5. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.
6. Provide ground rods and ground grid at service entrance equipment as required.
7. Bond the neutral of each transformer to building steel.
8. All underground grounding conductors shall be a minimum of 2'-6" below grade.
9. Provide a ground wire in all feeder circuits.
10. Provide a ground wire in all branch circuit conduits.
11. Where grounding conductors are subject to mechanical injury, they shall be protected by encasement in concrete or installed in a rigid schedule 80 PVC raceway.
12. All connection of ground conductors to ground rods, bus bars, structural members, pipes, or fences and splices of ground conductors shall be made by exothermic welds, except where otherwise noted.
    a. All connections to bar lugs shall be exothermic weld or compression type.

b. Bolted type connection of ground conductors may only be made where terminal lugs or blocks have been furnished and installed in equipment by the Manufacturer.
c. Prior to the installation of any exothermic weld on connector, all connecting surfaces shall be thoroughly cleaned in accordance with the Manufacturer's recommendations.
d. Failure to thoroughly clean connecting surfaces shall constitute justifiable ground to require the Contractor to remove and re-install all similar connections at no expense to the Owner or Engineer.

13. The Contractor shall not allow or cause any connection or splice for the grounding system to be covered up or enclosed until it has been inspected and approved by the Inspecting Authority.
    a. Any connection or splice that is covered up or enclosed before such inspection and approval shall be uncovered at the Contractor's expense.
    b. After it has been inspected and approved, the Contractor shall cover up or enclose the connection or splice it at his own expense.
14. The resistance to ground for the entire grounding system shall not exceed 25 ohms under normal dry conditions. Tests of grounding resistance shall not be made within 24 hr after a rainfall. If, after testing the system, it is found that the resistance exceeds the specified value, the Contractor shall install the necessary number of ground rods to reduce the resistance to less than the specified value.

B. Connections
1. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
    a. Use electroplated or hot tin coated materials to assure high conductivity and make contact points closer in order of galvanic series.
    b. Make connections with clean bare metal at points of contact.
    c. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
2. Exothermic Welded Connections: Use for connections to structural steel, connections to ground rods, and for all underground connections. Install at connections to ground rods. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
3. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
4. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
5. Compression Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

6. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

C. Underground Distribution System Grounding
1. Manholes, Handholes, and Underground Pullboxes: Install a driven ground rod close to the wall and set the rod depth such that 4 inches will extend above the finished floor. Where necessary, install ground rod before the manhole is placed and provide a No. 1 AWG bare tinned copper conductor from the ground rod into the manhole through a waterproof sleeve in the manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure sensitive tape or heat shrunk insulating sleeve from 2 inches above to 6 inches below the concrete. Seal floor opening with waterproof nonshrink grout.
2. Connections at Manholes, Handholes, and Underground Pullboxes: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole to the ground rod or ground conductor. Connect circuit ground wire to ground rod. Make connections with minimum No. 4 AWG stranded hard drawn copper wire. Train conductors plumb or level around corners and fasten to manhole or handhole walls. Connect to cable armor and cable shields by means of tinned terminals soldered to the armor or shield, or as recommended by manufacturer of splicing and termination kits.
3. Grounding System: Ground noncurrent carrying metallic items associated with manholes, substations, and pad mounted equipment by connecting them to bare underground cable and grounding electrodes arranged as indicated.

3.2 APPLICATION

A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated. Use of conduit system for ground conductor shall not be allowed.
1. Install separate insulated equipment grounding conductors with circuit conductors for the following in addition to those locations where required by code:
a. Feeders and branch circuits.
2. Nonmetallic Raceways: Install an insulated equipment ground conductor in nonmetallic raceways unless they are designated for telephone or data cables.

B. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.

C. Separately derived systems required by NEC to be grounded shall be grounded in accordance with NEC paragraph 250-30.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.

3.3 FIELD QUALITY CONTROL

A. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.

B. Test the complete station ground system for continuity and for resistance to ground using an electrical ground resistance tester.

C. Ground test shall be performed only after two days of dry weather. Dry weather is defined as 0.0-inch of precipitation in a 48 hour period.

D. Use a hand-cranked or motor-driven ground test set by Biddle, or approved equal.

E. Resistance to ground shall be 5 ohms or less. Drive additional ground rods as required to meet the 5 ohm maximum resistance.

F. All tests are to be witnessed by the Owner's Representative. Notify the Owner's Representative at least 24 hours in advance of testing.

END OF SECTION 26 0526

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SECTION 26 0529

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to work of this Section.

B. This section is a Division 26 section and is a part of each Division 26 section making reference to electrical supporting devices specified herein.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install supporting devices in accordance with the plans and as specified herein.

B. Supports: Types of supports, anchors, sleeves and seals specified in this section include the following:
1. Clevis hangers.
2. Riser clamps.
3. C-clamps.
4. I-beam clamps.
5. One hole conduit straps.
6. Two hole conduit straps.
7. Round steel rods.
8. Lead expansion anchors.
9. Toggle bolts.
10. Wall and floor seals.
11. U-channel strut system.

C. Supports, anchors, sleeves and seals furnished as part of factory fabricated equipment, are specified as part of that equipment assembly in other divisions and Division 26 sections.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. National Electrical Code (NEC) Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.
2. Manufacturer's Standardization Society (MSS) Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.
3. National Electrical Contractors Association (NECA) Compliance: Comply with NECA's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

4. Underwriters' Laboratories, Inc. (UL) Compliance: Provide electrical components which are UL listed and labeled.
5. Federal Specification (FS) Compliance: Comply with FS FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

1.4 DEFINITIONS

A. Abbreviations
1. PVC: Polyvinyl chloride.

B. Finished Locations: The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

F. Hazardous (classified) Locations: The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
1. Product data for the U-channel strut system.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Deliver supporting devices properly packaged in factory fabricated type container.

B. Store supporting devices in clean dry space in original containers. Protect products from weather damaging fumes, construction debris and traffic.

C. Handle supporting devices carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Products shall include but are not limited to the following:
   1. Materials
      a. Corrosive locations. Type 316 stainless steel or PVC coated galvanized steel.
      b. Exterior locations. Type 316 stainless steel.
      c. All other locations. Steel or malleable iron, electro-galvanized.
   2. Clevis Hangers: For supporting rigid metal conduit.
      a. 3/8-inch rod for 2 inch and smaller conduit.
      b. 1/2-inch rod for 2 1/2 inch and larger conduit.
   3. Threaded Rod: 1/2-inch minimum size except as stated in 1 above with hexagon nuts.
   4. Beam Clamp: With 1/4-inch tapped side and back holes for attachment of conduit clamps.
   5. Swivel Beam Clamp: Swivel eye hook, closed in the installed position, swivel eye tapped for the threaded rod, and jamb nut.
   6. One-Hole Conduit Straps: One hole.
   7. Clamp Backs: For use with one hole conduit strap to support conduit away from wall or ceiling surface.
   8. Conduit Hangers: For hanging conduit from beam clamps, 1/4-20 closure bolt and square nut, hole for 1/2-13 threaded rod.
   9. Conduit Spacers: Nonmetallic spacers to support conduit and maintain spacing during concrete pours.
   10. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
      a. Appleton.
      b. Cal Conduit Products.
      c. Cantex, Inc.
      d. Carlon.
      e. Cooper B-line
      f. Crouse-Hinds.
      g. Gibson Stainless and Specialty, Inc.
      h. Killark.
      i. Occidental Coating Co.
      j. Raco, Inc.
      k. Robroy.
      l. Thomas & Betts Corp.

B. Cable and Cord Supports
   1. External Cable Grips
      a. For flexible cords and cables longer than 6 feet and steel support wire.
      b. Lace type split wire mesh.
      c. Single or double weave as required to support the load with a safety factor of 10 times the supported load.
      d. Type 302/304 stainless steel
   2. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
      a. B-Line Systems.
      b. Condux International, Inc.
      c. Kellems, Division of Hubbell, Inc.

d. O-Z/Gedney.
e. Pass & Seymour/Legrand.
f. Red Seal Electric Co.

2.2 U-CHANNEL STRUT SYSTEMS

A. General
1. Provide equipment that is listed and labeled.
2. U-channel
3. Materials
a. Corrosive locations: Type 316 stainless steel.
b. Exterior locations: Type 316 stainless steel.
c. All other locations: Cold rolled steel, ASTM A570, grade 33, 12 gauge, hot dip galvanized after fabrication.
4. Outside dimensions of 1-5/8 inch x 1-5/8 inch, unless otherwise noted.
5. Holes, 9/16 inch diameter at 1-7/8 inch on center, unless otherwise noted.
6. Provide spring nuts, clamps, hangers, and hardware made of the same materials at the U-channel.

B. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
1. Cooper/B-Line.
2. Gibson Stainless and Speciality, Inc.
3. Kindorf/Thomas & Betts.
4. Seasafe, Inc.
5. Unistrut Corporation.

2.3 FABRICATED SUPPORTS

A. General.
1. Constructed of individual structural shapes or assemblies of structural shapes welded together to form a complete, secure, and durable assembly.
2. Structural tubing, angles, channels, or W-shapes as shown on the drawings or required to support equipment or systems.
3. Size support members to perform their support functions without deflection of more than one half percent of total height for vertical members and 1 percent of total span for other than vertical members.
4. Materials
a. Corrosive locations: Type 316 stainless steel.
b. Exterior locations: Type 316 stainless steel.
c. All other locations: Cold rolled steel, ASTM A 36 hot dip galvanized after fabrication.

B. Fabrication
1. Steel: Assemble fabricated supports by full penetration welded connections.
2. Ground welds smooth and flush.
3. Wire brush areas around welds to remove slag and spall.

2.4 WALL AND FLOOR SEALS

A. General: Provide seals around conduits that penetrate below grade or water-bearing concrete walls and floors.

B. Wall Opening
   1. New Walls: Molded non-metallic high density polyethylene sleeves with integral water stop and end caps to prevent deformation during concrete pour.
   2. Existing Walls: Core drilled hole, size as recommended by seal manufacturer.

C. Modular seal.
   1. Inter-locking synthetic rubber links shaped to fill the annular space between the conduit and the wall opening.
   2. Glass reinforced nylon polymer pressure plates.
   3. Type 316 stainless steel bolts and flange hex nuts.

D. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
   1. PSI-Thunderline/Link-Seal.
   2. Or approved equal.

2.5 FIRE-STOPS

A. General
   1. Provide fire-stops around any electrical work penetrating fire rated walls, floors, or ceilings.
   2. Provide fire-stops that conform to the following:
      a. UL Standard 1479, "Penetration Fire-stop Systems."
      b. UL Standard 263, "Fire Tests of Building Construction and Materials."

B. Busway, Cable Tray, Armored Cable, and Conduit Penetration Fire-Stopping
   1. Provide expanding foam or elastomeric putty or pillows to fire-stop penetrations in fire rated assemblies.
      a. RTV Foam
         1) Dow Corning 3-6548 Silicone RTV Foam.
         2) 3M Fire Barrier 2001 Silicone RTV Foam.
      b. Elastomeric Putty
         1) 3M Fire Barrier 2000 (nonslump).
         2) 3M Fire Barrier 2003 (self-leveling).
         3) Nelson CLK N/S (nonsag).
         4) Nelson CLK S/L (self-leveling).
   2. Provide fire resistive panels on both sides of the fire barrier penetration if required to obtain the necessary fire resistance rating or to provide a cofferdam to restrain the sealant material during the installation and curing process.
      a. 3M Fire Barrier CS-195+.
      b. Nelson CPS.
      c. Or approved equal.

2.6 ANCHORS AND FASTENERS

A. General
   1. Provide anchors and fasteners, including bolts, nuts, washers of types, sizes and materials indicated.
   2. Materials
      a. Corrosive locations: Stainless steel.
      b. Exterior locations: Stainless steel.
      c. All other locations: Galvanized steel.
   3. Anchors for securing 3/4 or 1 inch conduit straps and device boxes to sound concrete walls and ceilings shall be self-tapping anchors, similar and equal to Hilti Kwik-Con II or ITW Buildex Blue Max, 3/16 inch by minimum 1 1/4 inches long, in areas not requiring stainless steel.
   4. For anchors for use in securing conduit larger than 1 inch, heavier equipment than device boxes, and all fasteners to be used in areas enumerated above as requiring stainless steel fasteners, provide stud type expansion anchors, drop-in two-piece expansion anchors, or adhesive stud anchors, similar and equal to Hilti Kwik-Bolt II, Hilti HDI Drop-in, or Hilti HVA Adhesive Anchor System.
   5. Lead Expansion Anchors: 1/2 inch.
   6. Toggle Bolts: Springhead, 3/16 inch x 4 inch.

B. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
   1. Ackerman Johnson Fastening Systems Inc.
   2. Ideal Industries, Inc.
   3. Hilti.
   4. Joslyn Manufacturing and Supply Co.
   5. ITW Buildex.
   6. Ideal Industries, Inc.
   7. Rawlplug Co.
   8. Star Expansion Co.
   9. U.S. Expansion Bolt Co.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

D. Install conduit seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal. Provide seals for the interior of conduits which penetrate exterior or water bearing walls, consisting of gland type sealing bushings or RTV closed cell silicone foam.

END OF SECTION 26 0529

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SECTION 26 0533

RACEWAY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
1. Flexible metal conduit (FMC).
2. Intermediate metal conduit (IMC).
3. Liquid-tight flexible metal conduit (LFMC).
4. Liquid-tight flexible non-metallic conduit (LFNC).
5. PVC coated rigid metal conduit.
6. Rigid aluminum conduit (RAC).
7. Rigid non-metallic conduit (RNC).
8. Surface raceway.
9. Wireway.

B. Related Sections
1. Division 01 section "Submittal Procedures."
2. Division 26 section "Basic Electrical Requirements."
3. Division 26 section "Basic Electrical Materials and Methods."
4. Division 26 section "Grounding."
5. Division 26 section "Supporting Devices."
6. Division 26 section "Electrical Identification."
7. Division 31 section "Excavation and Fill."

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. American National Standards Institute (ANSI)
1. C80.1 Standard for Electrical Rigid Steel Conduit (ERSC).
2. C80.3 Standard for Steel Electrical Metallic Tubing (EMT).
3. C80.5 Standard for Electrical Rigid Aluminum Conduit (ERAC).

C. National Electrical Contractors Association (NECA) Electrical Installation Standards
1. 101-2006 Standard for Installing Steel Conduit (Rigid, IMC, EMT)
2. 102-2004, Standard for Installing Aluminum Rigid Metal Conduit
3. 111-2003, Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)

D. National Electrical Manufacturers Association (NEMA)
1. RN 1 Polyvinyl-chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

2. TC-2 Electrical Polyvinyl Chloride (PVC) Conduit.

E. National Fire Protection Association (NFPA)
1. NFPA70 – The National Electrical Code (NEC).

F. Underwriter's Laboratory (UL)
1. Standard 1 Flexible Metal Conduit
2. Standard 5 Surface Metal Raceway and Fittings
3. Standard 6 Rigid Metal Conduit
4. Standard 50 Enclosures for Electrical Equipment
5. Standard 360 Liquid-Tight Flexible Steel Conduit
6. Standard 467 Grounding and Bonding Equipment
7. Standard 514A Metallic Outlet Boxes
8. Standard 514B Fittings for Cable and Conduit
9. Standard 651 Schedule 40 and 80 Rigid PVC Conduit
10. Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit
11. Standard 797 Electrical Metallic Tubing
12. Standard 1242 Intermediate Metal Conduit
13. Standard 1660 Liquid-Tight Flexible Nonmetallic Conduit

1.4 DEFINITIONS

A. Abbreviations
1. AHJ: Authority having jurisdiction.
2. NRTL: Nationally recognized testing laboratory.
3. PVC: Polyvinyl chloride.

B. Finished Locations: The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

F. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information necessary to determine compliance with the plans and specifications.
   4. Identify all products submitted as substitutions.

B. Product Data
   1. Manufacturer’s technical product data sheets for all products specified in this section.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
   1. Materials list. Submit a list with quantities, manufacturer’s name, and catalog numbers.
   2. Dimensional drawings. Submit dimensional drawings for all products.
   3. Mounting details.
   4. Wiring diagrams: Submit wiring diagrams for all products.
      a. Show all components and features specified.
      b. Differentiate between factory and field installed wiring and components.

D. Samples

E. Quality Control Submittals
   1. Test Reports
      a. Field test report. Submit certified copies of the field test reports.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. All applicable federal, state, and local codes and regulatory requirements.
   2. National Electrical Code (NEC).

1.7 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirements Sections.

B. Packing and shipping
   1. Package equipment as required to prevent damage during shipment.
   2. Mount heavy items on pallets or skids to facilitate handling.

C. Storage and protection
   1. Store the products until they can be installed.
   2. Meet the storage requirements of the manufacturer.

1.8 PROJECT/SITE CONDITIONS

A. Field Measurements: Field verify all locations and dimensions.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Provide products listed and labeled by an approved independent NRTL.
   3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 CONDUITS

A. Minimum Conduit Size
   1. For Connection to Recessed Lighting Fixtures: 1/2 inch.
   2. For Connection to Field Instruments with Only 1/2 Inch Openings or Hubs: 1/2 inch.
   3. Duct Banks: 1 inch.
   4. All Other Uses: 3/4 inch.

B. Metal Conduit and Tubing
   1. Rigid Aluminum Conduit: Rigid aluminum conduit, threaded type, ANSI C80.5, UL6A.
   2. Intermediate Steel Conduit. Intermediate grade, hot dip galvanized, ANSI C80.1, UL 1242.
   3. Flexible Metal Conduit. Continuous, spirally wound, interlocked aluminum, UL 1
   4. Liquid-tight Flexible Metal Conduit: Continuous, spirally wound, interlocked aluminum, flexible liquid-tight PVC jacket, UL 360.
   5. Available Manufacturers: Subject to compliance, metal conduit manufacturers include, but are not limited to:
      a. AFC.
      b. Alflex Corp.
      c. Allied Tube and Conduit.
      d. Alumax.
      e. Electri-Flex Company.
      f. LTV Steel Tubular Products Co.
      g. Occidental Coating Co.
      h. Perma-Cote Industries.
      i. Robroy Industries, Inc.
      j. Shamrock Conduit Products.
      k. Tiften Aluminum Co.
      l. Triangle PWC, Inc.
      m. VAW of America Inc.
      n. Wheatland Tube Co.

C. Nonmetallic Conduit
   1. Rigid Nonmetallic Conduit: PVC, Schedule 40, NEMA TC-2, UL 651.
   2. Rigid Nonmetallic Conduit (Heavy Wall): PVC, Schedule 80, NEMA TC-2, UL 651.
   3. Liquid-tight Flexible Nonmetallic Conduit: Continuous hard PVC spiral encapsulated with flexible PVC, UL 1660.
   4. Available Manufacturers: Subject to compliance, non-metallic conduit manufacturers include, but are not limited to:
      a. Alflex.
      b. Cantex Industries.
      c. Carlon.

d. Certainteed.
e. Cole Flex-Corp.
f. Electric-Flex.

2.3 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Bodies
1. Provide covers and gaskets secured with corrosion resistant screws.
2. Rigid Metal: Threaded aluminum, UL 514B.
3. Hazardous locations. Threaded aluminum approved for hazardous locations as identified on plans.
4. Nonmetallic: PVC, molded solvent weld connector, UL 514B.

B. Locknuts: Galvanized steel, bonding type with sharp edge for digging into metal, UL 514B, NEMA FB-1. Set screw type grounding terminal where required.

C. Bushings: Malleable iron, galvanized, integrally molded insulation, UL 514B, NEMA FB-1. Set screw type grounding terminal where required.

D. Conduit Hub Assemblies: Cast metal, ribbed body with female threads, o-ring gasket, integral conduit nipple with insulated throat, grounding type locknut, UL 514B.

E. Expansion Fittings
1. Rigid Aluminum Conduit: Aluminum body and sleeve, threaded ends, grounding type, rated for location where required.
2. Rigid Non-Metallic Conduit: PVC body and sleeve, two o-rings, socket connector each end.

F. Other Fittings
1. Rigid Metal: Threaded aluminum.
2. Liquid-Tight Flexible Metal: Compression type, galvanized steel or malleable iron body, steel ferrule, sealing gland and gasket, insulated throat.
3. Rigid Nonmetallic: PVC, molded solvent weld connector, NEMA TC 3.
4. Liquid-Tight Flexible Nonmetallic: PVC, one piece body, compression ferrule, sealing gland and gasket.

G. Explosion-Proof Seals: Rated use in Class I, Division 1, Group D atmosphere.

H. Explosion-proof couplings. Braided wire outer jacket, insulating inner liner, threaded ends, liquid-tight, length as required. Rated for use in Class I, Division 1, Group D hazardous locations.

I. Conduit Seals
1. Duct Sealing Putty
a. Gray pliable mastic.
b. Non-shrink, non-hardening and UV resistant.
c. Compatible with wire insulation.
d. Listed for use with conduit sealing fitting.
2. Mechanical Seals
a. Internal sealing bushing.
b. Two stainless steel pressure discs

c. Three stainless steel socket head cap screws
d. Neoprene gasket.
e. Pressure discs and gasket factory predrilled to match size/quantity of cables.
f. Rated to withstand 50 pounds per square inch gauge (psig) water or gas pressure.

3. Expanding foam sealant
   a. Two part foam that expands in place to fill voids between cables and conduits.
   b. Compatible with wire/cable insulation.
   c. Withstands 15 feet of water head.
4. Expanding Foam Fire Stop Sealant
   a. Two part silicone foam that expands to fill voids between cables and conduits.
   b. Compatible with wire/cable insulation.
   c. Intumescent, listed as a fire barrier.

J. Available Manufacturers: Subject to compliance, conduit fitting manufacturers include, but are not limited to:

1. Fittings
   a. Adalet/PLM.
   b. Appleton Electric.
   c. Carlon.
   d. Condux International, Inc.
   e. Crouse-Hinds.
   f. Delta Industrial Products.
   g. Electri-Flex Company.
   h. Killark Electric Mfg. Co.
   i. Kraloy Products Co.
   j. O.Z. Gedney.
   k. Perma-Cote Industries.
   l. Raco.
   m. Robroy Industries.
   n. Spring City Electrical Mfg. Co.
   o. Steel City.
2. Sealants
   a. 3M.
   b. Dow.
   c. Gardner Bender Electrical.
   d. Panduit.

2.4 WIREWAYS

A. General Purpose Wireways. NEMA 1 steel, front accessible, totally enclosed with bolted covers. Finished with rust-inhibiting primer and gray baked enamel finish.

B. Oil-tight Wireways. NEMA 12, oil-tight and dust-tight steel with hinged cover and gasket, external latches, and flanged joints with gaskets. Finished with gray baked enamel inside and outside.

C. Watertight Wireways. NEMA 4X, watertight, corrosion resistant stainless steel with hinged cover and gasket, screw clamps, and flanged joints with gaskets.

D. Available Manufacturers. Subject to compliance, wireway manufacturers include, but are not limited to:

1. American Electric.
2. Anchor Electric Co.
3. B-Line Systems, Inc.
4. Circle AW Products.
5. Cross Brothers, Inc.
6. Erickson Electric Equipment Co.
7. GS Metals Corp.
8. Hoffman Engineering Co.
9. Square D Company.
10. Wadsworth Electric Manufacturing Co., Inc.

2.5 SURFACE RACEWAYS

A. Metal Raceways. [Aluminum] [Galvanized steel] with snap-on covers. 1/8-inch mounting screw, knockouts in base approximately 8 inches on center. Finished with rust-inhibiting primer suitable for painting.

B. Nonmetallic Raceways. Two piece construction, rigid PVC with matte texture conforming to UL 94.

C. Available Manufacturers. Subject to compliance, surface raceway manufacturers include, but are not limited to:
1. Surface Metal Raceway.
   a. Alrey-Thompson Co., Inc.
   b. Allied Tube & Conduit.
   c. American Electric.
   d. B-Line Systems, Inc.
   e. Butler Mfg. Co.
   f. Erickson Electrical Equipment Co.
   g. GS Metals Corp.
   h. Haydon Corp.
   i. Hoffman Engineering Co.
   j. Isoduct Energy Systems.
   k. Isotrol Systems.
   l. Keystone/Rees, Inc.
   m. SL Industries, Inc.
   n. Square D Co.
   o. The Wiremold Co.
2. Surface Nonmetallic Raceway.
   a. Anixter Brothers, Inc.
   b. Hoffman Engineering Co.
   c. Hubbell, Inc.
   d. JBC Enterprises, Inc.
   e. Panduit Corp.
   f. Premier Telecom Products, Inc.
   g. Thermotools Co.
   h. The Wiremold Co.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Inspect installed work prior to performing the work of this section.
   2. Verify that the project has progressed to a point where this installation may begin.

B. Material Inspection.

C. Discrepancies:
   1. Immediately notify the Engineer in writing of conditions detrimental to proper completion of the work.
   2. Correct all unsatisfactory conditions before proceeding with installation.
   3. Resolution must be acceptable to the Engineer.

3.2 RACEWAY APPLICATIONS

A. Conduit
   1. Connections to Motors or Vibrating Equipment
      a. Hazardous locations: Flexible coupling rated for the area.
      b. Corrosive locations: Liquid-tight flexible non-metallic conduit, 18 inch maximum length.
      c. Wet locations: Liquid-tight flexible metal conduit, 18 inch maximum length.
      d. All other locations: Liquid-tight flexible metal conduit, 18 inch maximum length.
   2. Concealed in Walls and Fixed Ceilings
      a. Hazardous locations: Do not conceal conduits.
      b. Corrosive locations: Do not conceal conduits.
      c. Wet locations: Do not conceal conduits.
      d. Finished locations: Rigid aluminum conduit.
      e. All other locations: Do not conceal conduits.
   3. Concealed in Accessible Floors and Ceilings
      a. Finished locations: Rigid aluminum conduit.
      b. Connections to lighting fixtures: Flexible metal conduit, 6 feet maximum length.
      c. All other locations: Rigid aluminum conduit.
   4. Concealed in Concrete
      a. Hazardous locations: Schedule 40 PVC conduit.
      b. Corrosive locations: Schedule 40 PVC conduit.
      c. Wet locations: Schedule 40 PVC conduit.
      d. Transitions from concealed in concrete to exposed: Schedule 80 PVC conduit.
      e. All other locations: Schedule 40 PVC conduit.
   5. Exposed
      a. Hazardous locations: Rigid aluminum conduit.
      b. Corrosive locations: Schedule 80 PVC conduit.
      c. Wet locations: Rigid aluminum conduit.
      d. Finished locations: Do not expose conduits in finished areas.
      e. All other locations: Rigid aluminum conduit.
   6. Underground
      a. Direct buried: Schedule 80 PVC conduit
      b. Concrete encased: Schedule 40 PVC conduit.
      c. Transitions from underground to exposed: PVC coated RMC.

B. Fittings
   1. Use threaded fittings and conduit bodies for rigid aluminum conduit.
   2. Use reducing couplings or bushings for transitions between conduit sizes.

C. Conduit Seals
1. Use hazardous location sealing fitting where required by the NEC.
2. Use expanding foam fire stop sealant in fire rated wall, floor, and ceilings.
3. Use mechanical seals in exterior below grade walls, floors, and ceilings.
4. Use expanding foam sealant for all other conduit seals.

D. Wireways
1. Finished locations: Do not use wireways in finished locations.
2. All other locations: Use NEMA 4X wireways.

E. Surface raceway:
1. Use only where shown.

3.3 PREPARATION

A. Surface Preparation
1. Carefully lay out the work in advance.
2. Perform all cutting, drilling, etc. without damaging the building surfaces or equipment.

B. Rough-in
1. Refer to equipment submittals for rough-in requirements.
2. Verify rough-in locations by field measurements.
3. Maintain all manufacturer recommended clearances.

3.4 CONDUIT INSTALLATION

A. General
1. Install raceways in accordance with the following:
   a. Manufacturer's written installation instructions
   b. NECA 1, NEC, and UL
2. Remove and replace the damaged raceways with new undamaged material.
3. Install plumb and level.
4. Install complete runs before pulling in cables or wires.
5. Cap all conduits after installation with factory made closures.
6. Install pull rope in all spare or empty conduits.
7. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength.
8. Make pull-line continuous from outlet to outlet, with two feet of slack at each outlet.
9. Embed the ends in duct sealing compound.
10. Provide enough slack in flexible conduits to facilitate maintenance of equipment.
11. Limits bends between pull points to no more than 4 bends totaling 360 degrees.

B. Field fabrication and assembly
1. General
   a. Make all bends with standard conduit bending tools and machines.
   b. Do not to distort or vary the internal diameter when field bending.
   c. Keep legs of bends in the same plane.
   d. Keep straight legs of offsets parallel, unless otherwise indicated.
   e. Make couplings and connections watertight.
   f. Remove and replace dented or deformed conduit with new undamaged material.
   g. Cut conduits straight
   h. Ream cut ends to remove burrs.

2. Rigid Aluminum Conduit
    a. Ream cut ends before threading.
    b. Do not use running threads at conduit joints and terminations.
    c. Clean the threads and conduit interior with a degreasing spray.
3. PVC Coated RMC
    a. General
        1) Follow general conduit installation requirements except as modified below.
        2) Follow the manufacturer's recommended installation procedures.
        3) Protect PVC coating on conduit and fittings from damage prior to and during the Work.
    b. Cutting and threading.
        1) Cut conduit using only roller cutters.
        2) Replace pipe vise jaws with jaws designed for use with PVC coated conduit.
        3) Use power drive unit inserts designed for use with PVC coated conduit.
        4) Use half shell conduit clamps in chain vises.
        5) Machine threading tool stationary guide to accommodate the PVC coating.
        6) Make longitudinal release cuts in the PVC coating before threading.
        7) Clean the threads and conduit interior with a degreasing spray.
        8) Apply touchup compound to any unprotected metal.
    c. Bending
        1) Use bending shoes specifically designed for PVC coated conduit in mechanical bending equipment.
        2) Use shoes one size larger than the size of the conduit when hand bending.
        3) Use bending hickeys that have a PVC coating.
    d. Assembly
        1) Use strap wrenches or wide jaw pliers designed for PVC coated conduit.
        2) Use nut drivers for encapsulated fasteners on conduit body and enclosure covers.
    e. Repair and replacement
        1) If PVC coating of conduit or fittings is damage during installation, remove and replace with new undamaged materials.
        2) Repair minor scratches or damage in PVC coating with touchup compound where allowed by the Owner's representative.
4. Rigid Nonmetallic Conduit
    a. Solvent weld all joints in PVC conduit to provide a watertight seal.
    b. Provide a seal that maintains pressure of 25 pounds per square inch for 1 hour.

C. Routing
1. General.
    a. Locations are approximate unless dimensioned.
    b. Install exposed conduits parallel or perpendicular to walls, ceilings, or structural members.
    c. Run parallel or banked raceways together on common supports where practical.
    d. Make bends in parallel or banked runs from same center line.
    e. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
    f. Avoid conflicts with equipment and building components.
    g. Do not run through structural members.
    h. Avoid horizontal runs within partitions or walls.
    i. Align raceways to enter boxes and cabinets squarely.
    j. Avoid ceiling inserts, lights, or ventilation ducts or outlets.

k. Do not run across pipe shafts or ventilation duct openings
l. Maintain 6 inches of separation to parallel runs of flues and other heat sources.
m. Install horizontal runs above water and steam piping wherever possible.
n. Install horizontal runs close to ceilings or beams.
o. Do not encroach into the head room of walkways and doors.
p. Do not install within fume/vent hoods except where serving the fume/vent hood.
q. Provide a low point in conduit runs before entering boxes/enclosures.
r. Install a tee conduit fitting and drain/breather at the low point.
s. Enter the bottom of boxes/enclosures located in wet, hazardous, or corrosive areas.

2. Finished Areas
   a. Conceal in walls, slabs, or ceilings.
   b. In existing areas, conceal in walls of stud construction and above suspended ceilings.
3. Installed in Concrete
   a. Install in concrete only where specifically shown or specified.
   b. Do not install in waterproofed or water-bearing walls.
   c. Do not install through concrete beams.
   d. Do not install in concrete that is less than 3 inches thick.
   e. Do not install in concrete with a thickness less than 3 times the conduit diameter.
   f. Do not install between the reinforcing steel and the surface of the concrete.
   g. Space parallel runs at twice the diameter of the largest conduit, center to center.
   h. Do not cross conduits in slabs unless reviewed by the Engineer/Architect for proper cover.
   i. Make transitions from embedded to exposed with a metal conduit extending 1 inch into concrete.
4. Other Interior Areas
   a. Where equipment is more than 3 feet from walls, run in or under the floor and stub up.
   b. Run all other interior conduits exposed.
5. Exposed Exterior
   a. Do not run exposed on the exterior surface of buildings.
   b. Do not run across access openings in handrail.
   c. Do not run on the inside walls of tanks.
6. Underground Conduits
   a. Encase all underground conduits in concrete unless otherwise noted.
   b. Where noted as direct buried, provide 6 inches of sand above and below conduits.
   c. Depth below finished grade to top of underground conduits.
      1) Circuits less than or equal to 600 Volts. 24 inches.
      2) Circuits greater than 600 Volts. 36 inches.
   d. Provide excavation and backfill as specified in Division 31 Section, “Excavation and Fill”.
   e. Make all changes of direction with bends of 30 inch radius minimum.
   f. Space conduits 7.5 inches center to center both horizontally and vertically.
   g. Slope away from buildings with a minimum pitch of 3 inches per 100 feet.
   h. Mark underground conduit runs as specified in Section 260553, Electrical Identification.
   i. Provide reinforcing steel for 5 feet beyond excavation where conduits cross back-filled areas.
   j. Run parallel to plant coordinate axes when outside of structures and underground, unless otherwise shown.

D. Supports
   1. Support all conduits as specified in Section 260529, Supporting Devices.
   2. Support all conduits entering structures as shown on the Drawings.
   3. Use only products listed as conduit supports.
   4. Do not attach any parts of the conduit system to ventilation ducts.
   5. Attached conduit supports to the building.
   6. Support conduits on each side of bends.
   7. Support conduits at a spacing not to exceed the following:
      a. Six feet for conduits smaller than 1-1/4 inches
      b. Eight feet for conduits 1-1/4 inches and larger.
   8. Use waterproof cement to set conduit anchors in water bearing or waterproofed walls.
   9. Securely anchor underground conduits to prevent movement during placement of concrete or backfill.
   10. Secure embedded raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   11. Use precast separators and heavy gauge wire ties or other approved fasteners.
   12. Support conduits independently of suspended ceilings, lighting fixtures.
   13. Unless otherwise shown or specified, support conduit independently of process piping, mechanical piping, or mechanical ducts.
   14. Support within 1 foot of changes of direction, and entries to boxes or enclosures.

E. Sealing and Penetrations
   1. Seal the interior of the following conduits to prevent migration of moisture and gases:
      a. Conduits passing from warm to cold locations.
      b. Conduits passing between areas where air pressure differential must be maintained.
      c. Conduits subject to condensation.
      d. Conduits passing from the interior to the exterior of a building.
      e. Conduits penetrating exterior below grade walls, floors, and ceilings.
      f. Conduits entering any panelboard, switchboard, switchgear, or motor control center.
      g. Conduits entering any control panel.
      h. Conduits entering all exterior manholes, handholes, and boxes.
      i. Empty or spare conduits.
   2. Seal the interior of all conduits penetrating fire rated walls, floors, and ceilings.
      a. Seal penetrations with a fire rated sealant.
      b. Install fire rated sealants in accordance with manufacturer's instructions.
      c. Provide a foam depth of at least one conduit trade size.
   3. Conduit Stub-Ups
      a. Protect stub-ups from damage where conduits rise through floor slabs.
      b. Arrange stub-ups so curved portion of bends are not visible above the finished slab.
      c. Terminate stub-ups that are more that 6 inches from a wall with a threaded metal coupling and plug installed flush with the floor.
      d. Terminate all other stub-ups with a threaded cap or a bushing and penny.
   4. Provide wall and floor seals at conduit penetrations as specified in Section 260529, Supporting Devices.
   5. Roofs:
      a. Penetrate roofs only where specifically shown in the Contract Documents.
      b. Provide penetrations that meet the requirements of Division 07, Thermal and Moisture Protection.

F. Grounding
1. Mechanically assemble metal raceways to form a continuous effective grounding path.
2. Ensure that terminations at boxes and enclosures provide an effective ground connection.
3. Provide grounding bushings for the following metallic conduit connections:
   a. Circuits of more than 100 amperes.
   b. Connections through concentric, eccentric or oversize knockouts.
   c. Flexible conduit connections
   d. Any enclosure entry without an effective electrical connection.
4. Locknut and Bushing Grounding Lugs
   a. Bond together all lugs within the same box or enclosure with bonding jumpers.
   b. Bond lugs to the enclosure ground bus where provided.
   c. If a ground bus is not provided, bond lugs to an enclosure grounding stud or screw.
   d. For conduit transitions to cable tray, bond bushing ground lug to tray ground clamp.
5. Size bonding jumpers in accordance with NEC table 250.102.
6. Apply approved conductive joint compound to mating surfaces of all grounding connections.

G. Painting and Coating
1. Coat all field cuts and threads with brush applied cold process galvanizing, ASTM A 780.
2. Coat aluminum conduits with a dielectric isolating compound where installed in contact with reinforced concrete.

H. Identification: Identify conduits as required in Division 26 Section “Electrical Identification”.

3.5 CONDUIT FITTING INSTALLATION

A. General
1. Join with fittings designed and approved for that purpose.
2. Make-up couplings, fittings, and locknuts wrench-tight.
3. Install locknuts with dished side against box.
4. Use approved conductive thread compounds on all threaded connections.
5. Install a bushing on all conduit ends.
6. Provide a tee fitting with drain/breather at all low points.
7. Terminate Rigid Aluminum Conduit at NEMA 1 and NEMA 12 boxes and enclosures with two locknuts, one inside and one outside, and a bushing.
8. Terminate Rigid Aluminum Conduit at NEMA 3R, NEMA 4, NEMA 4X boxes and enclosures with conduit hub assemblies or in integral hubs where available.

B. Hazardous Locations
1. Provide sealing fittings where required by the NEC.
2. Follow the installation instructions of the manufacturer.

C. Expansion Fittings
1. Provide expansion fittings wherever structural expansion joints are crossed.
2. Provide expansion fittings for every 200 feet of linear run.
3. Provide expansion and deflection couplings wherever shown.
4. Install expansion fittings within one foot to five feet of structural expansion joint.
5. Do not use expansion fittings to compensate for misalignment of conduits.
6. Seismic Areas:
   a. Provide a rigidly attached junction box on each side of structural expansion joints.

b. Connect junction boxes with flexible conduit and provide 15 inches of slack.

3.6 WIREWAY AND SURFACE RACEWAY INSTALLATION

A. General:
1. Install in accordance with the following:
   a. Manufacturer's written installation instructions
   b. NECA 1, NEC, and UL.
2. Install only where shown.
3. Install plumb and level.
4. Install parallel or perpendicular to wall, floors, ceilings, or structural members.
5. Mechanically assemble to form continuous electrical conductor.
6. Support as specified in Division 26 section "Supporting Devices."

B. Rough-in dimensions:
1. Use dimensions for utilization equipment that are provided in the submittals.
2. Maintain all manufacturer recommended clearances.
3. Install only after the locations clear with other trades.

C. Supporting: Support as specified in Division 26 section "Supporting Devices.".

3.7 FIELD QUALITY CONTROL

A. Check alignment and condition of conduits:
1. Pull a mandrel and swab through every completed conduit run.
2. Use an iron shot mandrel:
   a. Mandrel diameter: 1/4 inch less than nominal conduit size
   b. Mandrel length: Equal to the conduit diameter.
   c. Gasket diameter: Slightly larger than the conduit opening.
3. Draw mandrel through without mechanical assistance.
4. If obstructions are encountered that cannot be removed, correct or replace conduit.

B. Test Nonmetallic Conduits for Leaks
1. Test conduits after conduit run is complete and cemented joints are set.
2. Conduct test as recommended by manufacturer.
3. Exercise caution, low-pressure air can cause high thrust loads.

C. Notify the Engineer for inspection and sign-off of the following installations:
1. Conduits to be direct buried: Notify the Engineer prior to covering.
2. Conduits to be embedded in concrete: Notify the Engineer prior to pouring concrete.
3. Document when each conduit is tested and cleaned and submit test report.

3.8 CLEANING

A. Conduits
1. Pull a stiff brush through each conduit until it is clear of foreign materials.
2. Clean existing ducts used for new cable in the same manner as noted above.

B. Wireways: Remove any dirt or debris from wireways before installing wiring.

END OF SECTION 26 0533

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SECTION 26 0553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to perform the work in accordance with the plans and as specified herein.

B. This section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
   1. Buried electrical line warnings.
   2. Identification labeling for raceways, cables, and conductors.
   3. Operational instruction signs.
   4. Warning and caution signs.
   5. Equipment labels and signs.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with electrical identification in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

B. Electrical Component Standard: Components and installation shall comply with National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."

C. American National Standards Institute (ANSI) Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

1.4 DEFINITIONS

A. Abbreviations
   1. AHJ: Authority having jurisdiction.

1.5 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required

B. Provide submittal for approval of format, descriptions, and contents prior to fabrication.

C. Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for each type of product specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Box, Conduit, and Raceway Identification
   1. Adhesive Labels: Preprinted, flexible, self-adhesive orange vinyl labels with black legend. Legend covered with clear weather and chemical resistant coating.
   2. Plastic Sleeves: Preprinted, pretensioned, snap-on, flexible, wraparound plastic sleeves with black legend. Sized to fit conduit diameter.
   3. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
   4. Buried Line Warning Tape: Permanent, bright colored, continuous printed, plastic warning tape not less than 6 inches wide by 4 mils thick with continuous metallic strip or core. Printed legend indicative of general type of underground line below.

B. Wire and Cable Identification
   1. Colored Marking Tape: Self-adhesive vinyl tape not less than 7 mils thick and 3/4 inch wide.
   2. Wire Labels: Self-adhesive wraparound labels with clear heat shrinkable jacket or permanent plastic heat shrinkable labels. Preprinted legends.

C. Nameplates and Signs
   1. Laminated Plastic: Engraving stock plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Engrave legend in black letters on white face unless otherwise noted and punched for mechanical fasteners.
   2. Metal Backed Butyrate: Weather resistant, nonfading, preprinted cellulose acetate butyrate signs with 20 gauge, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4 inch grommets in corners for mounting.
   3. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fasteners. Dimensions: 2 inches by 2 inches by 19 gauge.

D. Accessories
   1. Fasteners: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
   2. Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking nylon cable ties, 0.18 inch minimum width, 50 pound minimum tensile strength, and suitable for a temperature range from minus 40 degrees Fahrenheit (° F.) to 185° F. Provide ties in specified colors when used for color coding.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
   1. American Labelmark Co.; Labelmaster Subsidiary
   2. Brady USA, Inc.; Industrial Products Div.
   3. Calpico, Inc.

4. Carlton Industries, Inc.
5. Champion American, Inc.
6. Cole-Flex Corp.
7. D&G Sign and Label.
8. Emed Co., Inc.
9. George-Ingraham Corp. (The)
10. Grimco, Inc.
11. Ideal Industries, Inc.
12. Kraftbilt.
13. LEM Products, Inc.
14. Markal Corp.
15. National Band and Tag Co.
16. Panduit Corp.
17. Radar Engineers.
18. Ready Made Sign Co.; Cornerstone Direct Corp. Div.
19. Seton Name Plate Co.
20. Standard Signs, Inc.
21. W. H. Brady, Co.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conduits
1. Underground Lines: Identify with warning tape in trench above conduits.

B. Boxes
1. Code Required Caution Signs: Self-adhesive labels indicating system voltage. Install on outside of box cover.
2. Circuit Identification: Self-adhesive labels indicating contained circuits.

C. Wires and Cables
1. Color Coding
a. Color code service, feeder, and branch circuit conductors as follows:

208/120 Volts	**Phase**	**480/277 Volts**
Black	A	Brown
Red	B	Orange*
Blue	C	Yellow
White	Neutral	White
Green	Ground	Green

*Where not permitted by inspecting authority, use purple.

b. Use conductors with color factory applied for sizes No. 8 AWG and smaller.
c. Use colored marking tape for sizes larger than No. 8 AWG. Apply for a distance of 6 inches from terminal points and in boxes where splices or taps are made.

2. Circuit Identification: Use aluminum wraparound marker bands to identify feeders and branch circuits in manholes, handholes, and pull boxes.
3. Conductor Labeling: Use wire labels to identify conductors as follows:
   a. Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
   b. Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three circuit, four wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation.
   c. Label all control, communication, signal, and metering conductors with wire numbers matching the numbers on the approved shop drawings from the system integrator.
   d. Match identification markings with designations used in panelboards, shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
   e. Provide securely attached nameplates identifying all ground buses. Provide securely attached nametags to each accessible termination, attachment, or bonding location for each equipment grounding conductor, grounding electrode conductor, and bonding conductor.

D. Signs
1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to ensure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. For emergency operating signs, install engraved laminate signs with white legend on red background with minimum 3/8 inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
3. Provide code required signs for multiple main switches, for standby power systems, and, where required, for generator ground connection.

E. Nameplates
1. General: Provide equipment identification nameplates for each major unit of electrical equipment, including central or master units of each electrical system. This includes communication/signal/alarm systems unless unit is specified with its own self-explanatory identification. Text shall match terminology and numbering of the contract documents and shop drawings.
2. Provide 1-1/2 inch high engraved plastic laminated nameplates (2 inches high where two lines of text are required) with 1/2 inch lettering for the following:
   a. Panelboards, electrical cabinets, and enclosures.
   b. Switchboards.
   c. Motor control centers.
   d. Motor starters.
   e. Power transfer equipment.
   f. Contactors.

g. Transformers.
h. Enclosed circuit breakers.
i. Disconnect switches.
j. Control panels.

3. Provide 5/8 inch high engraved plastic laminated nameplates (1 inch high where two lines of text are required) with 1/4 inch high lettering for individual compartments of the following:
   a. Switchboards.
   b. Motor control centers.
4. Provide 5/8 inch high engraved plastic laminated nameplates (1 inch high where two lines of text are required) with 1/4 inch high lettering for the following:
   a. Control stations.
   b. Control devices.
   c. Light switches.
5. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. All code requirements for signage shall be met.

3.2 INSTALLATION

A. General
   1. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
   2. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC. Clean surfaces of dust, loose material, and oily films before applying.
   3. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
   4. Install labels where indicated or at locations for best viewing without interference with operation and maintenance of equipment.

B. Buried Line Warning Tape: During trench backfilling, for exterior underground power, control, signal, and communications cables and conduits, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.

C. Tape: Apply colored, pressure sensitive plastic tape in half-lapped turns. Apply the last two turns of tape with no tension to prevent possible unwinding. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

D. Metal Tags: Attach metal tags with one piece self-locking nylon cable ties.

E. Cable Ties: Apply cable ties with a special tool or pliers; tighten for snug fit and cut off excess length.

END OF SECTION 26 0553

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SECTION 26 0900

CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
   1. Pilot devices (push buttons, pilot lights, etc.).
   2. Elapsed time meters.
   3. Relays and timers.
   4. Intrinsically Safe Relays.
   5. Zener Barriers.
   6. Sensing devices (limit switches, proximity switches, etc.).
   7. Alarms and signals.

B. Related Sections
   1. Division 01 section, "Submittal Procedures."
   2. Division 01 section, "Operation and Maintenance Data."
   3. Division 26 Section “Electrical Identification”.

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. Underwriter's Laboratory (UL)

C. National Electrical Manufacturers Association (NEMA)

D. National Fire Protection Association (NFPA)

E. American National Standards Institute (ANSI)

F. Institute for Electrical and Electronics Engineers (IEEE)

G. The Instrumentation, Systems, and Automation Society (ISA)

H. American Society for Testing and Materials (ASTM)

1.4 DEFINITIONS

A. Abbreviations
   1. AHJ: Authority having jurisdiction.
   2. DPDT: Double pole double throw.
   3. NRTL: Nationally recognized testing laboratory.

4. SPST: Single pole single throw.
5. SPDT: Single pole double throw.

B. Finished Locations: For the purposes of this specification, the following are finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: For the purposes of this specification, the following are interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: For the purposes of this specification, the following are wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: For the purposes of this specification, the following are corrosive locations.
1. All locations with chemical feed/transfer equipment, chemical storage tanks, or chemical storage drums are located.

F. Hazardous (Classified) Locations
1. Hazardous (classified) locations as defined by the NEC.
2. Hazardous locations and their classification are shown.

1.5 SUBMITTALS

A. General
1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
2. Provide all information necessary to determine compliance with the plans and specifications.

B. Product Data
1. Manufacturer’s technical product data sheets for all products specified in this section.
2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
1. Wiring Diagrams: Submit wiring diagrams for all products.
a. Show all components and features specified.
b. Differentiate between factory and field installed wiring and components.

D. Contract Closeout Submittals: Operation and maintenance (O&M) data.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.
   3. All units of the same type must be from the same manufacturer.

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Provide products listed and labeled by an approved independent NRTL.
   3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 PILOT DEVICES

A. General
   1. Round, heavy-duty, 30.5 mm.
   2. NEMA rated equal to enclosure.
   3. 5 amp NEMA B600 sealed contacts.
   4. Type and quantity of contacts as shown on drawings.

B. Push Buttons
   1. Momentary contact.
   2. Extended head
   3. Color as shown on drawings or specified in other specification sections.

C. Emergency Stop Push Buttons
   1. Maintained contact
   2. Push/pull operator
   3. 2-1/4 inch diameter mushroom head
   4. Red.

D. Selector Switches
   1. Maintained contact, unless otherwise shown.
   2. Number of positions as shown on drawings.

E. Cylinder Lock Operator
   1. Push button or selector switch type as shown on drawings.
   2. Operable only with key in lock.
   3. Provide two keys.

F. Pilot Lights
   1. Push-to-test LED type.
   2. Lens and lamp color as shown on drawings.

G. Legend Plates
   1. Extra large size
   2. Engraved laminated plastic
   3. Color
      a. Normal: Black legend on white background
      b. Emergency stop: Black legend on red background.

H. Accessories: Provide the following accessories where shown on the drawings.
   1. Padlocking Cover. Pad-lockable cover to prevent operation of pilot device.
   2. Protective Boot. Flexible plastic designed to prevent entrance of foreign materials.

I. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Allen Bradley Company.
   2. Cutler Hammer.
   3. Square D Company.

2.3 ELAPSED TIME METERS

A. General: 120 volt, synchronous motor driven, mechanical register indicating up to 99,999.9 hours.

B. Window Kit: Type 304 stainless steel frame, brushed finish, polycarbonate window, oil resistant gasket, NEMA 4X rated.

C. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Cramer Company.
   2. Hobbs.
   3. Industrial Timer Company.
   4. Redington Counters, Inc.
   5. Syrelec/Crouset Corporation.
   6. Weschler.

2.4 RELAYS AND TIMERS

A. General Purpose Relays: General purpose, plug in, tube base, transparent polycarbonate housing, 3PDT, 10 amp contact rating, coil voltage as shown on drawings.

B. General Purpose Timing Relays: General purpose, plug in, tube base, solid state, DPDT, 10 amp contacts, switch selectable timing mode (on delay, off delay, repeat cycle), switch selectable timing range (up to 10 hours). Voltage rating as shown on drawings.

C. Power Relays: DPDT, 30 amp, 1-1/2 horsepower rated contacts, coil voltage as shown on drawings.

D. Alternators: Two load alternator, plug in, tube base, 10 amp contact rating, DPDT cross connected, solid state alternating circuit, load 1-alternate-load 2 selector switch, voltage rating as shown on drawings.

E. Mounting Sockets: Surface mounted, tube base, screw terminals, with retaining strap.

F. Shall include a LED and mechanical visual indicator to indicate relay is energized.

G. Shall include push-to-test-pull-to-lock button manual operator.

H. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:

1. Allen Bradley Company.
2. Cutler Hammer.
3. Furnas Electric Company.
4. General Electric Company.
5. Potter and Brumfield, Inc.
6. Releco.
7. Square D Company.
8. SSAC, Inc.
9. Time Mark Corporation.

2.5 INTRINSICALLY SAFE RELAYS

A. Type: Dual or single channel transformer type intrinsic safety barrier with built-in amplifier.

B. Power: 120VAC, 50-60Hz.

C. Power Consumption: 10VA maximum.

D. Input: Isolated from output and supply.

E. Output: Relay type SPST 2A/250V.

F. Mounting: DIN rail.

G. Operation Temperature: -45 deg F to + 131 deg F.

H. State Mode of Operation: Switch selectable each channel.

I. Fault Monitoring: LED indicator each channel (lead breakage).

J. Output Status Monitoring: LED indicator each channel.

K. Approvals:
1. UL Listed or recognized component.
2. Approved for providing intrinsically safe circuits for use in Class I, Div. 1 Hazardous Locations.

L. Manufacturers:
1. Pepperl and Fuchs.
2. Phoenix Contact.
3. Or approved equal.

2.6 ZENER BARRIERS

A. Type: Dual channel zener barriers which accept 24Vdc field transmitter inputs and limit hazardous area energy to levels below that which could ignite a specific gas/air mixture.

B. Working Voltage: 27Vdc.

C. Maximum Voltage: 28Vdc.

D. Mounting: DIN rail.

E. Approvals: FM approved for Class I, Div. 1, Group D areas.

F. Operation Temperature: -45 deg F to + 131 deg F.

G. Manufacturers:
1. Pepperl and Fuchs.
2. Phoenix Contact.
3. Or approved equal.

2.7 SENSING DEVICES

A. Limit Switches.
1. NEMA 4X.
2. Four operating head mounting positions.
3. DPDT contacts, momentary.
4. Operating head style: As required per installation location.
5. Stainless steel operating lever.

B. Proximity Sensors.
1. Inductive, shielded type.
2. Stainless steel housing, 30 mm cylindrical.
3. NEMA 4X, unless otherwise noted.
4. Normally open contact.
5. Voltage rating as shown on drawings.

C. Door Switches.
1. Two piece, surface mount.
2. Magnet assembly for mounting on the door.
3. Magnetically actuated reed switch assembly for mounting on the door jamb.
4. Normally open contact, 24 VDC.

D. Manufacturers. Subject to compliance, provide products manufactured by one of the following:

E. Available Manufacturers. Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
1. Allen Bradley Company.
2. Cutler Hammer.
3. Edwards.
4. Furnas Electric Company.
5. General Electric.
6. Simplex.
7. Square D Company.

2.8 ALARMS AND SIGNALS

A. Horns.
1. Vibrating diaphragm type.
2. Minimum sound output of 100 decibels (dB) at 10 feet.
3. Enclosure. NEMA 4X, with matching mounting box.
4. Voltage rating. 120 VAC, unless otherwise shown.

B. Warning Lights.
   1. Rotating sealed beam type.
   2. Incandescent lamp, 100 watt.
   3. NEMA 4X cast aluminum housing.
   4. Lexan dome color as shown on plans.
   5. Voltage rating. 120 VAC, unless otherwise shown.

C. Strobe Lights.
   1. High intensity strobe, 100,000 candlepower minimum.
   2. Self-contained power supply.
   3. NEMA 4X cast aluminum housing.
   4. Lexan dome color as shown on plans
   5. Voltage rating. 120 VAC, unless otherwise shown.

D. Manufacturers. Subject to compliance, provide products manufactured by one of the following:

E. Available Manufacturers. Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Benjamin Division, Thomas Industries.
   2. Federal Signal Corporation.
   3. Maxi Signal Products, Division of MV Specialties.

2.9 TERMINAL BLOCKS

A. General: NEMA style, rail mounted, tin-plated copper, screw type with pressure plate, 600 volt rated, wire range No. 22 to No. 8 American Wire Gauge (AWG).

B. Fuse Blocks: Integral fuse puller and blown fuse indicator.

C. Isolating Blocks: Knife style.

D. Accessories
   1. Mounting rail.
   2. End barriers and end anchors.

E. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Allen Bradley Company.
   2. Buchanan.
   3. Cutler-Hammer Products.
   4. Phoenix Contact.
   5. Square D Company.

2.10 CONTROL POWER TRANSFORMERS

A. General: Copper windings, vacuum impregnated, open type, 480 volt primary and 120 volt secondary unless otherwise shown, with top mounted fuse block.

B. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Allen Bradley Company.

2. Cutler-Hammer Products.
3. Heavy Duty.
4. Square D Company.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
1. Inspect installed work prior to performing the work of this section.
2. Verify that the project has progressed to a point where this installation may begin.

B. Discrepancies
1. Immediately notify the Engineer in writing if any discrepancies are found.
2. Resolve all discrepancies before proceeding with installation.
3. Resolution must be acceptable to the Engineer.

3.2 PREPARATION

A. Surface Preparation
1. Carefully lay out the work in advance.
2. Perform any cutting , drilling, etc. without damaging the building surfaces or equipment.

B. Rough-In
1. Refer to equipment submittals for rough-in requirements.
2. Verify rough-in locations by field measurements.

3.3 INSTALLATION OF CONTROL DEVICES

A. General.
1. Install in accordance with manufacturer's written instructions.
2. Follow applicable requirements of National Electrical Contractors Association's (NECA) "Standard of Installation."
3. Coordinate with other work, including painting.
4. Install control devices only in boxes that are clean and free from dirt and debris.
5. Install control and indicating devices after wiring work is completed.
6. Install control devices in enclosures as required under other sections and as shown.
7. Tighten connectors and terminals to manufacturer's published torque tightening values.
8. Where manufacturer's torque requirements are not indicated, comply with UL 486A.

B. Grounding
1. Provide equipment grounding connections for control and indicating devices.
2. Tighten connection to comply with tightening torque specified in UL Standard 486A.

3.4 TESTING

A. General.
1. Prior to energizing circuitry, test control stations for electrical continuity.
2. After completion, demonstrate capability and compliance with project requirements.

END OF SECTION 26 0900

SECTION 26 2200

TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install transformers in accordance with the plans and as specified herein.

B. Work of this Section includes, but is not limited to:
   1. Dry-type distribution transformers.
   2. Individual K-rated dry type transformers.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work to furnish and install transformers in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Electrical Component Standard: Components and installation shall comply with National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."
   2. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Compliance: Comply with applicable requirements of ANSI/IEEE Standards including C2, "National Electrical Safety Code," and C57.12.80, "Terminology for Power and Distribution Transformers."
   3. Nationally Recognized Testing Laboratory Compliance (NRTL): Items provided under this section shall be NRTL listed and labeled. The term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.

B. Qualifications
   1. Manufacturer Qualifications: Member firm of National Electrical Manufacturers Association (NEMA) who is regularly engaged in manufacturing components that comply with the requirements of these specifications and that have been used on at least five projects of similar size and scope as this project.
   2. Testing: Manufacturer's standard shop test shall be performed in accordance with the latest version of ANSI and NEMA standards and shall include as a minimum the following. Provide certified factory test reports.
      a. Ratio tests at the rated voltage connection and at all tap connections.
      b. Polarity and phase relation tests on the rated voltage connection.
      c. Applied potential tests.
      d. Induced potential tests.
      e. No-load and excitation current at rated voltage on the rated voltage connection.
   3. Field Testing Organization Qualifications: To qualify for acceptance, an independent testing organization must demonstrate, based on evaluation of organization submitted

criteria conforming to American Society for Testing and Materials (ASTM) E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Wiring diagrams from manufacturer differentiating between manufacturer installed and field installed wiring.

C. Product certificates, signed by manufacturer of transformers certifying that their products comply with the specified requirements.

PART 2 - PRODUCTS

2.1 TRANSFORMERS, GENERAL

A. Transformers: Factory assembled and tested, air cooled units of types specified, having characteristics and ratings as indicated. Units shall be designed for 60 Hertz (Hz) service.
1. Cores: Grain oriented, non-aging silicon steel.
2. Coils: Continuous copper windings without splices except for taps.
3. Internal Coil Connections: Brazed or pressure type.

B. General Purpose, Dry Type Transformers
1. Comply with NEMA Standard ST 20 "Dry Type Transformers for General Applications."
2. Windings: Two winding type. Three phase transformers shall use one coil per phase in primary and secondary.
3. Enclosures: Indoor ventilated, unless noted otherwise.
4. Insulation Class: 185 deg C or 220 deg C class for transformers 15 kilovolt amperes (kVA) or smaller; 220 deg C class for transformers larger than 15 kVA.
5. Insulation Temperature Rise: 115 deg C maximum rise above 40 deg C.
6. Taps: For transformers 3 kVA and larger, full capacity taps in high voltage winding as follows:
   a. 15 - 500 kVA: Six 2.5% taps, two above and four below rated high voltage.
7. Accessories: The following accessory items are required where indicated:
   a. Wall Mounting Brackets. Manufacturer’s standard brackets for transformers sized up to 75 kVA where wall mounting is indicated.
8. Transformer sound levels shall not exceed ANSI standards.
9. Transformers installed in an area which has sprinklers shall have a weathershield.

C. K-Rated Transformers: K-rated transformers shall be as specified above, and in addition shall have the following features:
1. K-rating of not less than 13.
2. Secondary neutral terminal shall be sized for 200% of the secondary phase current.
3. Full width electrostatic shielding between primary and secondary winding and ground to the transformer core.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:
   1. Transformers
      a. Eaton Corporation.
      b. General Electric Company.
      c. Square D Company.
      d. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arrange equipment with a minimum clearance of 6 inches from any wall, to provide adequate spacing for cooling air circulation.

B. Identify transformers in accordance with Division 26 Section “Electrical Identification”.

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL Standards 486A and 486B.

D. Install units on vibration mounts as shown; comply with manufacturer's indicated installation method, if any.

E. Provide a housekeeping pad under all floor mounted transformers.

F. Install bracket for wall mounted transformers using anchors and fasteners suitable for the weight of the transformer and all accessories.

3.2 GROUNDING

A. Ground transformers and tighten connections to comply with tightening torques specified in UL Standard 486A.

B. Transformer secondary neutral shall be grounded to building structural steel in conformance with the NEC.

3.3 ADJUSTING AND CLEANING

A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

3.4 PROTECTION

A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 26 2200

SECTION 26 2716

CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to work of this Section.

B. This section is a Division 26 section, and is a part of each Division 26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install electrical boxes and fittings in accordance with the plans and as specified herein.

B. Types of electrical boxes and fittings specified in this section include the following:
1. Outlet boxes.
2. Junction boxes.
3. Pull boxes.
4. Floor boxes.
5. Bushings.
6. Locknuts.
7. Knockout closures.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. National Electrical Code (NEC) Compliance. Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
2. Underwriters' Laboratories (UL) Compliance. Comply with applicable requirements of UL 50, UL 514 Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes, fittings and enclosures which are UL listed and labeled.
3. National Electrical Manufacturer's Association (NEMA) Compliance. Comply with applicable requirements of NEMA Standard Publication Nos. OS1, OS2, and 250 pertaining to outlet and device boxes, covers, and box supports.
4. Federal Specification (FS) Compliance. Comply with applicable requirements of FS W-C-586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies and Entrance Caps."

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Shop Drawings for Electrical Boxes and Fittings: For shop-fabricated junction and pullboxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.

1.5 DEFINITIONS

A. Finished locations. The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

B. Interior locations. The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

C. Wet locations. The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

D. Corrosive locations. The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

E. Hazardous (classified) locations. The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Store cabinets, boxes and fittings in clean, dry space; protect products from weather, damaging fumes, construction debris and traffic.

PART 2 - PRODUCTS

2.1 ELECTRICAL BOXES AND FITTINGS

A. Electrical cabinets, boxes and fittings of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations. Provide corrosion-resistant box knockout closures to suit respective installation requirements and applications.

2.2 METALLIC OUTLET, DEVICE AND WIRING BOXES

A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical" and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application.

B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes, and

accessories suitable for each location, including mounting brackets and straps, cable clamps, exterior rings, and fixture studs.

C. Cast Aluminum Boxes: Copper-free aluminum threaded raceway entries and features and accessories suitable for each location including mounting ears, threaded screw holes for devices, and closure plugs.

2.3 NON-METALLIC OUTLET, DEVICE, AND WIRING BOXES

A. General: Conform to NEMA OS 2, "Non-Metallic Outlet Boxes, Device Boxes, Covers, and Box Supports," and UL 514C, "Non-Metallic Outlet Boxes, Flush Device Boxes, and Covers." Boxes shall be molded PVC units of type, shape, size, and depth to suit location and application.

B. Non-Metallic Boxes: Ultraviolet stabilized, non-conductive, high-impact-resistant boxes with integrally molded raceway entrance hubs and removable mounting flanges. Boxes shall be equipped with threaded screw holes for device and cover plate mounting. Each box shall have molded cover of matching polyvinyl chloride (PVC) material suitable for the application.

2.4 PULL AND JUNCTION BOXES

A. General: Comply with UL 50, "Electrical Cabinets and Boxes," for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted-on covers of same material as box and shall be of size and shape to suit application. All boxes 6-inch x 6-inch or larger shall have hinged doors. All boxes used for distribution of emergency power shall be painted red.

B. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanize after fabrication. Cover shall be gasketed.

C. Stainless Steel Boxes: Fabricate of stainless steel conforming to Type 302 of American Society for Testing and Materials (ASTM) A 167, "Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip." Where necessary to provide a rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.

D. Cast Aluminum Boxes: Molded of copper-free aluminum, with gasketed cover and integral threaded conduit entrances.

E. Cast Nonmetallic Boxes: Ultraviolet stabilized, non-conductive, high-impact-resistant PVC boxes with gasketed cover and integral mounting flanges.

2.5 STEEL ENCLOSURES WITH HINGED DOORS

A. General: Comply with UL 50, "Cabinets and Enclosures," and NEMA ICS6 "Enclosures for Industrial Control and Systems."

B. Construction: Sheet steel, 16-gauge, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface-mounting.

C. Doors: Hinged directly to cabinet and removable with approximately 3/4-inch flange around all edges, shaped to cover edge of box. Provide handle-operated, key-locking latch. Individual door width shall be no greater than 24 inches. Provide multiple doors where required.

D. Mounting Panel: Provide painted removable internal mounting panel for component installation.

E. Enclosure: NEMA 12, unless noted otherwise. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips.

2.6 CAST METALLIC ENCLOSURES WITH HINGED DOORS

A. General: Copper-free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for the classification of hazard involved.

2.7 MOLDED NONMETALLIC ENCLOSURES WITH HINGED DOOR

A. General: Molded, glass-fiber-reinforced high-impact-strength polyester with bolt or screw-secured doors and solid neoprene gaskets.

2.8 CORROSION INHIBITORS

A. General: All enclosures containing equipment, terminals, or splices shall have a vapor phase corrosion inhibitor. Provide two spares for each one installed.

2.9 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Adalet-PLM Div.; Scott Fetzer Co.
2. American Electric.
3. Arrow-Hart Div.; Crouse-Hinds, Co.
4. Appleton Electric Co.; Emerson Electric Co.
5. Harvey Hubbell, Inc.
6. OZ/Gedney Co.; General Signal Co.
7. Pass and Seymour, Inc.
8. Thomas & Betts Co., Inc.
9. Walker; Wire Mold Company.
10. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

A. Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractor's Association (NECA) "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Install items where indicated and where required to suit code requirements and installation conditions. Cap unused knockout hole where blanks have been removed and plug unused conduit hubs so as to maintain the NEMA rating of the box. Install boxes in locations which ensure ready accessibility to enclosed electrical wiring and avoid installing boxes back-to-back

in walls where there would be less than 6 inches (150 mm) separation. Fasten boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Do not install aluminum products in concrete.

C. Outlet and device boxes for flush-mounted installation shall be a minimum of 4-inch square or octagonal and positioned accurately to allow for surface finish thickness.

D. Junction boxes, pullboxes, and enclosures with hinged doors which are surface-mounted shall utilize spacers to maintain 1/4-inch clearance from the wall.

E. Floor boxes shall be installed level and flush with finish flooring material.

F. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and secure connections when fastened with locknut or bushing on rounded surfaces.

G. Provide electrical connections for installed boxes.

3.2 COORDINATION

A. Coordinate installation of electrical cabinets, boxes, and fittings with wire/cable, wiring devices, and raceway installation work.

3.3 APPLICATIONS

A. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
   1. Use galvanized flat rolled sheet steel boxes only in finished areas.
   2. Use PVC coated steel boxes in corrosive non-hazardous areas as designated on the plans.
   3. Use boxes suitable for the classification in hazardous area as shown on the plans.
   4. Use cast metal boxes in all other locations.

B. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location and in conformance with the following:
   1. Use hot-dipped galvanized steel boxes only in finished areas.
   2. Use stainless steel boxes in corrosive non-hazardous areas and as designated on the plans.
   3. Use boxes suitable for the classification in hazardous area as shown on the plans.
   4. Use NEMA 4X stainless steel or cast metal boxes in all other locations.

C. Enclosures with Hinged Doors: Install enclosures and associated materials and NEMA types suitable for each location and in conformance with the drawings.

D. Floor Boxes: Install cast iron floor boxes at each location indicated.

3.4 GROUNDING

A. General: Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

3.5 CLEANING AND FINISH REPAIR

A. General: Upon completion of installation, inspect components, remove burrs, dirt, and construction debris, and repair damaged finish including chips, scratches, abrasions, and weld marks.

END OF SECTION 26 2716

SECTION 26 2726

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
1. Receptacles.
2. Heavy-duty receptacles.
3. Hazardous location receptacles.
4. Snap switches.
5. Hazardous location snap switches.
6. Wallbox dimming controls.
7. Occupancy sensing light switches.
8. Communications outlets.
9. Covers and wall plates.

B. Related Sections
1. Division 01 Section “Submittal Procedures”.
2. Division 26 Section “Grounding”.
3. Division 26 Section “Electrical Identification”.

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. American National Standards Institute (ANSI)
1. ANSI/IEEE C62.41, IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
2. ANSI/NEMA WD 6, Wiring Devices—Dimensional Requirements.

C. ASTM International (ASTM)
1. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association (NEMA)
1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA Standard FB 11—Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
3. NEMA WD 1, General Color Requirements for Wiring Devices.

E. Telecommunications Industry Association (TIA)
1. TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.

F. Underwriter's Laboratory (UL)
1. UL 20, Standard for General-Use Snap Switches.
2. UL 498, Standard for Attachment Plugs and Receptacles.
3. UL 894, Standard for Switches For Use In Hazardous (Classified) Locations.
4. UL 943, Standard for Ground-Fault Circuit-Interrupters.
5. UL 1010, Standard for Receptacle-Plug Combinations For Use In Hazardous (Classified) Locations.
6. UL 1203, Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.
7. UL 1449, Standard for Surge Protection Devices.
8. UL 1472, Solid-State Dimming Controls.
9. UL 1682, Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type.
10. UL 1686, Standard for Pin and Sleeve Configurations.
11. UL 1863, Standard for Communications-Circuit Accessories.

1.4 DEFINITIONS

A. Abbreviations
1. AHJ: Authority Having Jurisdiction.
2. NRTL: Nationally Recognized Testing Laboratory.
3. GFCI: Ground-fault circuit interrupting.

B. Finished Locations: The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

F. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General
1. Comply with the requirements of Division 01 section, "Submittal Procedures".
2. Submit information as described below.
3. Provide all information necessary to determine compliance.

B. Product Data
   1. Manufacturer's technical product data sheets for all products specified in this section.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Samples: Submit sample of each type and color of wiring device and wall plate.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
   1. All applicable federal, state, and local codes and regulatory requirements.
   2. National Electrical Code (NEC).

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.
   3. All units of the same type must be from the same manufacturer.
   4. Provide nameplates conforming to Division 26 section, "Electrical Identification."

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Provide products listed and labeled by an approved independent NRTL.
   3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 RECEPTACLES

A. General
   1. Brass alloy power contacts and terminal screws.
   2. Side and back wired terminals.
   3. Self-grounding clip on mounting screw.
   4. Thermoplastic back cover.
   5. Nylon face.
   6. Suitable for solid or stranded copper wire.

B. General-Purpose Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL 498.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Single or duplex as shown.

C. GFCI Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL 498, UL 943.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Single or duplex as shown.
   6. Feed-through type.

7. Suitable for mounting in 2-3/4 inch box without adapter.

D. Isolated ground receptacles.
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL498.
   3. Straight blade NEMA WD6, 5-20R.
   4. Brass alloy mounting strap.
   5. Brass allow Isolated ground terminal, and ground contacts.
   6. Identified with orange triangle on face.

E. TVSS Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL498, UL 1449, ANSI/IEEE C62.41 Category A and B.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Integral TVSS in line to ground, line to neutral, and neutral to ground
      a. Multiple metal-oxide varistors.
      b. Nominal clamp level rating of 500 volts.
      c. Minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
   6. Condition indicator light and audible alert.
   7. Distinctive marking on face of device to denote TVSS-type unit.

F. Hospital grade receptacles.
   1. Hospital grade.
   2. NEMA WD 1, NEMA WD 6, UL498.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Identified with green dot on face.

G. Tamper-resistant receptacles.
   1. [Industrial specification grade][Hospital grade].
   2. NEMA WD 1, NEMA WD 6, UL498.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. UL listed as tamper-resistant.
   6. Internal shutter mechanism to limit access to energized components.
   7. Prevents object insertion unless both contacts are engaged.
   8. Identified with green dot on face.
   9. Identified on face as tamper-resistant.

H. Weather-resistant receptacles
   1. Industrial specification grade.
   2. UL listed as weather-resistant.
   3. NEMA WD 1, NEMA WD 6, UL 498.
   4. Ultraviolet light exposure, cold impact, and accelerated aging tests.
   5. Straight blade NEMA WD6, 5-20R.
   6. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   7. Single or duplex as shown.
   8. Identified on face as weather-resistant.

I. Corrosion-Resistant Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL 498.
   3. Pass ASTM B117, 500-hour salt spray test.
   4. Straight blade NEMA WD6, 5-20R.
   5. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   6. All metal parts nickel-plated.
   7. Nickel-plated mounting screws.
   8. Single or duplex as shown.

J. Receptacle Colors
   1. Normal Power: Ivory.
   2. Emergency Power: Red.
   3. TVSS Protected: Blue.
   4. Corrosion-resistant: Yellow.

K. Available Manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
   1. Hubbell Incorporated.
   2. Leviton Manufacturing Company Incorporated.
   3. Pass & Seymour/Legrand; Wiring Devices Division.

2.3 HEAVY-DUTY RECEPTACLES

A. General
   1. UL 498, UL 1682, UL 1686.
   2. Pin and sleeve type.
   3. Brass contacts.
   4. Cast aluminum body.
   5. Ampere rating as shown.
   6. Attached screw cap.
   7. Suitable for wet locations.
   8. Color coded and configured to a specific circuit voltage and current rating.
   9. Circuit breaking type, arc from disconnecting under load contained with an arc chamber.

B. Accessories
   1. Cast aluminum back box suitable for installed location.
   2. Matching plug for each receptacle.

C. Manufacturers: Subject to compliance, provide products by one of the following.
   1. Appleton.
   2. Arrow-Hart.
   3. Crouse-Hinds.

2.4 RECEPTACLES IN HAZARDOUS (CLASSIFIED) LOCATIONS

A. General
   1. Receptacles rated for specific hazardous locations shown.

B. General purpose receptacle
   1. UL 1010, NEMA WD 6, NEMA 250.

2. NEMA WD6 5-20R.
3. Cast aluminum body.
4. Brass contacts.
5. Factory sealed.
6. Attached cover with hinge and gasket.
7. Suitable for wet locations.
8. Circuit breaking type, plug cannot be removed until disconnecting mechanism rotated.

C. GFCI receptacle
1. UL 943, UL 1010, UL 1203, NEMA WD 6, NEMA 250.
2. NEMA WD6 5-20R.
3. Cast aluminum body.
4. Brass contacts.
5. Factory sealed receptacle.
6. Separate factory sealed GFCI unit.
7. Feed-thru type.
8. Attached receptacle cover with hinge and gasket.
9. Circuit breaking type, plug cannot be removed until disconnecting mechanism rotated.

D. Heavy-duty receptacle
1. UL 1010, UL 1686, NEMA FB 11, NEMA 250.
2. Pin and sleeve type.
3. Brass contacts.
4. Cast aluminum body.
5. Ampere rating as shown.
6. Attached receptacle cover with hinge and gasket.
7. Suitable for wet locations.
8. Color coded and configured to a specific circuit voltage and current rating.
9. Circuit breaking type, arc from disconnecting under load contained with an arc chamber.

E. Accessories
1. Cast aluminum back box suitable for installed location.
2. Matching plug for each receptacle.

F. Available manufacturers. Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Appleton.
2. Crouse-Hinds.

2.5 SNAP SWITCHES

A. General
1. Single-pole, 2-pole, 3-way, 4-way and illuminated handle snap switches as shown.
2. NEMA WD 1, UL 20.

B. Construction
1. Quiet-type alternating current (ac) switches, 20 ampere, 120-277 volt.
2. Side and back wired, screw pressure terminal.
3. Brass alloy terminal screws.
4. Yoke grounding screw.
5. Thermoplastic back cover.

6. Suitable for solid or stranded copper wire.
7. Switch handle color: Ivory.

C. Available Manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Hubbell Incorporated.
2. Leviton Manufacturing Company Incorporated.
3. Pass & Seymour/Legrand; Wiring Devices Division.

2.6 SNAP SWITCHES IN HAZARDOUS (CLASSIFIED) LOCATIONS

A. General
1. UL 20, UL 894, NEMA WD 1, NEMA 250.
2. Rated 20 ampere, 120-277 volt AC.
3. Quiet-type alternating current (ac) switches, 20 ampere, 120-277 volt.
4. Side and back wired, screw pressure terminal.
5. Brass alloy terminal screws.
6. Yoke grounding screw.
7. Thermoplastic back cover.
8. Suitable for solid or stranded copper wire.
9. Cast metal enclosure and cover rated for specific hazardous locations shown.

B. Available manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Appleton.
2. Crouse-Hinds.

2.7 WALLBOX DIMMING CONTROLS

A. General
1. UL 1472.
2. Solid-state full-wave dimmer.
3. Integral, quiet on/off switch, with audible frequency and EMI/RFI suppression filters.
4. Single-pole, 3-way, and 4-way switching.
5. Continuously adjustable slider control.
6. Illuminated when off.

B. Incandescent lamp dimming controls
1. 120 V.
2. Follow square-law dimming curve.
3. Bypass dimmer module with on/off switch positions.
4. Rated wattage: 600 with no de-rating when ganged with other devices.

C. Fluorescent lamp dimming controls
1. Modular; compatible with dimming ballasts.
2. Trim potentiometer to adjust low-end dimming.
3. Dimmer-ballast combination low end dimming down to 20 percent of full brightness.

D. Available manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Lutron.

2. Or approved equal.

2.8 OCCUPANCY SENSING LIGHT SWITCHES

A. Wall-Switch Sensors
   1. Wall box mounted.
   2. Dual voltage (120 and 277 volts).
   3. Dual technology passive-infrared and ultrasonic.
   4. One hundred eighty degree field of view.
   5. Adjustable time delay up to 30 minutes.
   6. Adjustable sensitivity.
   7. Suitable for electronic ballast inrush currents.
   8. Minimum coverage area of 900 square feet.

B. Long-Range Wall-Switch Sensors
   1. Wall box mounted.
   2. Dual voltage (120 and 277 volts).
   3. Passive infrared type.
   4. One hundred ten degree field of view.
   5. Adjustable time delay up to 30 minutes.
   6. Adjustable sensitivity.
   7. Suitable for electronic ballast inrush currents.
   8. Minimum coverage area of 1200 square feet.

C. Wide-Range Wall-Switch Sensors
   1. Wall box mounted.
   2. Dual voltage (120 and 277 volts).
   3. Passive infrared type.
   4. One hundred fifty degree field of view.
   5. Adjustable time delay up to 30 minutes.
   6. Adjustable sensitivity.
   7. Suitable for electronic ballast inrush currents.
   8. Minimum coverage area of 1200 square feet.

D. Exterior Occupancy Sensors
   1. Weatherproof.
   2. Dual voltage (120 and 277 volts).
   3. Passive infrared type.
   4. One hundred eighty degree field of view.
   5. Adjustable time delay up to 15 minutes.
   6. One hundred ten foot detection range.
   7. Suitable for electronic ballast inrush currents.

E. Manufacturers: Subject to compliance, provide products by one of the following:
   1. Hubbell.
   2. Leviton.
   3. Pass & Seymour.
   4. Watt Stopper.

2.9 COMMUNICATIONS OUTLETS

A. Telephone Outlet
   1. UL 1863, TIA/EIA-568-B.1 Category 5e.
   2. One RJ-45 jack.

B. Combination TV and Telephone Outlet
   1. UL 1863, TIA/EIA-568-B.1 Category 5e.
   2. One RJ-45 jack.
   3. One Type F coaxial cable connector.

C. Available manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
   1. Cooper.
   2. Leviton.

2.10 COVERS AND WALL PLATES

A. General
   1. UL 514D.
   2. Single and combination type with ganging and cut-outs as required.
   3. Metal plate-securing screws to match plate finish.

B. Finished Locations
   1. Minimum 0.05 inch thick.
   2. Type 302 satin stainless steel.

C. Other Interior Locations: Galvanized steel.

D. Weatherproof Covers
   1. Rain-proof while in use in compliance with NEC Article 410-57.
   2. Cast aluminum plate with neoprene gasket.
   3. Hinged, self-closing, cast aluminum device cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
   1. Verify outlet boxes are installed at proper locations and heights.
   2. Verify wall openings are neatly cut and will be completely covered by wall plates.
   3. Verify branch circuit wiring is completed, tested, and ready for connection to wiring devices.

B. Discrepancies
   1. Immediately notify the Engineer in writing of conditions detrimental to proper completion of the work.
   2. Correct all unsatisfactory conditions before proceeding with installation.
   3. Resolution must be acceptable to the Engineer.

C. Clean debris from outlet boxes before installing devices.

3.2 INSTALLATION

A. General
1. Install products following manufacturer's instructions.
2. Coordinate with other work, including painting, electrical boxes and wiring installations.
3. Install devices plumb, level, and secure.
4. Mount receptacles in finished areas at 1’-6” above the finished floor.
5. Mount receptacles in all other areas at 4’-0” above the finished floor.
6. Mount all wall switches at 4'-0" above finished floor.
7. Install wiring devices after wiring work is completed.
8. Install wall plates after painting work is completed.
9. Unless otherwise shown, mount devices flush, with long dimension vertical.
10. Group adjacent switches and receptacles under a single, multi-gang wall plate.
11. Do not use the duplex/split-wire break-off tabs in receptacles as circuit conductors for connecting downstream devices.
12. Install receptacles for electric water coolers (EWC) within the cabinet.

B. Dual-Level Lighting Control
1. Provide dual-level lighting control in spaces 100 square feet and larger.
2. Provide controls to reduce the lighting load by at least 50 percent.
3. Coordinate controls to reduce lighting in a reasonably uniform lighting pattern.
4. Coordinate dual-level lighting controls with day lighting apertures, such as windows.

C. Grounding
1. Ground wiring devices as specified in Division 26 section, "Grounding".
2. Connect grounding terminal to branch circuit equipment grounding conductor.

D. Identification: Identify wiring devices as required in Division 26 section, "Electrical Identification”.

3.3 FIELD QUALITY CONTROL

A. Inspections
1. Inspect each wiring device for defects before installing.
2. Have a qualified manufacturer’s representative inspect the installation.

B. Operate each operable device at least six times with circuit energized.

C. Receptacles
1. Test each 20-ampere receptacles for proper polarity and ground continuity.
2. Use a UL listed test device.

D. GFCI Receptacles
1. Test operation according to manufacturer recommendations.
2. Verify that GFCI will trip at 5 ±1 mA current.
3. Verify that GFCI does not trip at less than 1.8 mA current.

E. Replace damaged or defective wiring devices

3.4 ADJUSTING

A. Adjust each occupancy sensor.

B. Occupancy Sensor Time-Out Controls
   1. Utility, lunch/break, storage, and copier rooms: 5-minute time-out setting.
   2. Conference rooms: 10-minute time-out setting.
   3. Corridors and lobbies: 15-minute time-out setting.
   4. All other locations: longest time out setting, but not more than 30 minutes.

C. Ambient Light Sensor: Set to turn off lights when daylighting exceeds 80% of the design illuminance.

3.5 CLEANING

A. General
   1. Clean devices and wall plates.
   2. Replace stained or improperly painted wall plates or devices.
   3. Adjust devices and wall plates to be flush and level.

END OF SECTION 26 2726

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SECTION 26 2813

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install overcurrent protective devices (OCPDs) in accordance with the plans and as specified herein.

B. Work of this Section includes, but is not limited to:
   1. Fuses
      a. Fuses rated 600A and less.
      b. Fuses rated above 600A.
   2. Circuit breakers.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with overcurrent protective devices in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Electrical Component Standard: Components and installation shall comply with National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."
   2. Listing and Labeling: Provide products specified in this section that are listed and labeled (as defined as they are in the NEC, Article 100).
   3. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.

B. Single Source Responsibility: Obtain similar OCPDs from a single manufacturer.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submittals: Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for fuses, circuit breakers, and OCPD accessories specified in this section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

C. Reference Submittals
   1. Manufacturer's descriptive literature.
   2. Operating and maintenance instructions.
   3. Spare parts list.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver OCPDs and components in factory fabricated type containers or wrappings, which properly protect devices from damage.

B. Handle OCPDs carefully to prevent physical damage to OCPDs and components. Do not install damaged OCPDs; remove from site and replace damaged devices with new.

C. Store OCPDs in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

1.6 DEFINITIONS

A. OCPD: A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

B. Ampere Squared Seconds: An expression of available thermal energy resulting from current flow. With regard to current limiting fuses and circuit breakers, the ampere squared seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General
   1. Provide OCPDs in indicated types, as integral components of panelboards, switchboards, and motor control centers; and also as individually enclosed and mounted single units.
   2. Enclosures: National Electrical Manufacturers Association (NEMA) 250 "Enclosures for Electrical Equipment (1,000 volts Maximum)."

B. Cartridge Fuses
   1. NEMA Standard FU1, "Low Voltage Cartridge Fuses": Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used.
   2. Class J Fuses: Underwriters' Laboratories, Inc. (UL) 198C, "High Interrupting Capacity Fuses, Current Limiting Type".
   3. Class L Fuses: UL 198C, "High Interrupting Capacity Fuses, Current Limiting Type".
   4. Class RK1 and RK5 Dual Element Time Delay Fuses: UL 198E, "Class R Fuses".
   5. Provide a complete set of fuses for all fusible equipment on the job.
   6. All fuses shall be of the same manufacturer and shall have an interrupting rating of 200,000 A, RMS symmetrical, except where otherwise noted.
   7. All fuses shall bear UL label and class designation.
   8. Place fuse identification labels showing size and type of fuse installed inside the cover of each switch or piece of equipment.

9. Fuse voltage shall be as required for the service.
10. Fuses Rated 600A and Less
    a. Fuses which protect motor circuits and transformers shall be time delay type, UL Listed, Class RK-1, except where otherwise noted.
    b. Fuses which are protecting circuit breakers, circuit breaker panels, and resistive heating circuits shall be fast-acting, current limiting type, UL listed, Class J, except where otherwise noted.
11. Fuses Rated Above 600 A
    a. Fuses which protect motor circuits shall be time delay, current limiting type, UL listed, NEMA Class L, except where otherwise noted.
    b. Fuses which are protecting circuit breakers, circuit breaker panels, and resistive heating circuits shall be fast-acting, current-limiting type, UL listed, class L.

C. Circuit Breakers
1. Molded case type, with ampere rating, frame size and number of poles as shown.
2. Comply with the following:
    a. UL 489 "Molded Case Circuit Breakers and Circuit Breaker Enclosures."
    b. NEMA AB 1 "Molded Case Circuit Breakers."
    c. Federal Specification W-C-375.
3. Bolt in type, except breakers 225 ampere frame size and larger may be plug in type if held in place by positive locking device requiring mechanical release for removal.
4. Minimum RMS symmetrical short circuit interrupting capacity rating.
    a. 10,000 Amperes at 120/240V.
    b. 18,000 amperes at 277V.
    c. 35,000 amperes at 480V.
5. Quick make, quick break toggle mechanism.
6. Inverse time-current characteristic overload protection for each pole.
7. Instantaneous magnetic trip element short circuit protection for each pole.
8. Solid state trip device for circuit breaker frame sizes over 250 Amperes.
    a. Independently adjustable long time, short time, and instantaneous trip settings.
    b. Ground fault trip unit where shown, adjustable for pick up and time delay.
    c. Settings adjustable from front of breaker controls and/or plug-in element change.
    d. Indicator for cause of trip.
9. Provide circuit breakers appropriate for applications, including Type SWD for switching fluorescent lighting loads, and Type HACR for heating, air-conditioning, and refrigeration equipment.

D. OCPD Accessories
1. Provide key interlocks where shown.
    a. Arrange interlocking so keys are held captive at devices indicated.
    b. Where future key interlocking provisions are indicated, provide necessary mountings and hardware as required for the future installation.
2. Labels: Install label inside enclosure identifying the type of OCPD installed, its overcurrent rating, its interrupt rating and UL class. Where applicable, trip settings and time delays should be provided on permanent labels.

E. Extra Materials: For types and ratings required, furnish spare fuses, amounting to one fuse for every five installed fuses, but not less than one set of three of each type of fuse.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:
   1. Cartridge Fuses
      a. General Electric Co.
      b. Littelfuse Inc., Tracor, Inc.
   2. Molded Case Circuit Breakers
      a. Eaton Corporation.
      b. General Electric Company.
      c. Square D Company.
      d. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
   1. Install fuses and circuit breakers as indicated, in accordance manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with the NEC, and NEMA Standards.
   2. Inspect each circuit breaker and fuse visually.
   3. Perform several mechanical ON-OFF operations on each circuit breaker and switch.
   4. Verify circuit continuity on each pole in closed position.

B. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions.

C. OCPDs in distribution equipment shall be factory installed.

3.2 IDENTIFICATION

A. Identify components in accordance with Division 26, Section “Electrical Identification”.

3.3 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and UL 486B.

3.4 GROUNDING

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.5 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Include the following inspections and related work.
   1. Overcurrent Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make the final system adjustments.
   2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
   3. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
   4. Check tightness of electrical connections of OCPDs with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   5. Clean OCPDs using manufacturer's approved methods and materials.
   6. Verify installation of proper fuse types and ratings in fusible OCPDs.

3.6 CLEANING

A. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.7 DEMONSTRATION

A. Training: Arrange and pay for the services of factory authorized service representatives to demonstrate OCPDs and train Owner's maintenance personnel.

B. Conduct a minimum of one half day of training in operation and maintenance as specified under "Instructions to Owner Employees" in the "Project Closeout" section of these specifications. Include both classroom training and hands-on equipment operation and maintenance procedures.

C. Schedule training with at least 7 days' advance notification.

END OF SECTION 26 2813

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SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
   1. Service disconnecting means.
   2. Feeder and branch-circuit protection.
   3. Equipment disconnecting means.
   4. Motor circuit disconnecting means.

B. Related Sections
   1. Division 01 Section “Submittal Procedures”.
   2. Division 01 Section “Operation and Maintenance Data”.
   3. Division 26 Section “Electrical Identification”.
   4. Division 26 Section “Overcurrent Protective Devices”.

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. Underwriter's Laboratory, Inc. (UL)
   1. UL 98, Enclosed and Dead Front Switches.
   2. UL 486A-486B, Wire Connectors.

C. InterNational Electrical Testing Association (NETA)
   1. ATS, Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.

D. National Electrical Manufacturers Association (NEMA)
   1. NEMA KS 1, Enclosed Switches.
   2. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   3. NEMA AB1, Molded Case Circuit Breakers.

E. National Fire Protection Association (NFPA)
   1. NFPA 70, National Electrical Code (NEC).

1.4 DEFINITIONS

A. Abbreviations
   1. AHJ: Authority having jurisdiction.
   2. NRTL: Nationally recognized testing laboratory.

B. Interior Locations: The following are defined as interior locations:
   1. Any location within the boundaries of the foundation of any building.
   2. Any location within the superstructure of other structures not classified as buildings.

C. Wet Locations: The following are defined as wet locations:
   1. All exterior locations.
   2. All interior locations below grade.
   3. All interior locations where wet materials are processed, pumped, transported, or stored.

D. Corrosive Locations: The following are defined as corrosive locations.
   1. All locations with chemical feed/transfer equipment
   2. All locations with chemical storage tanks
   3. All locations where chemical storage drums are located.

E. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
   1. All hazardous (classified) locations and their hazard classification are shown.

F. Seismic Withstand: When subjected to the specified seismic forces, seismic withstand means:
   1. The unit will remain in place.
   2. No parts will separate from the unit.
   3. The unit will be fully operational after the seismic event.

1.5 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information needed to determine compliance.

B. Product Data
   1. Manufacturer’s technical product data sheets.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
   1. Dimensional drawings for enclosures.
   2. Time-current curves, including selectable ranges for each type of circuit breaker.
   3. Wiring Diagrams: Submit wiring diagrams for all products.
      a. Show all components and features specified.
      b. Differentiate between factory installed and field installed wiring and components.

D. Quality Control Submittals
   1. Manufacturer Seismic Qualification Certification
      a. Submit certification that products will withstand seismic forces defined in Division 26 section, "Seismic Controls for Electrical Work."
      b. Indicate whether certification is based on actual testing calculation.
      c. Identify center of gravity and locate and describe mounting and anchorage provisions on a dimensioned outline drawing.
      d. Provide description of equipment anchorage devices on which certification is based and their installation requirements.
   2. Qualification Data: Submit compliance data for testing agencies.

3. Manufacturer’s Instructions. Submit manufacturer's current installation instructions.

E. Contract Closeout Submittals
1. Project record documents.
2. Operation and Maintenance (O&M) Data
a. Comply with Division 01 section, "Operation and Maintenance Data."
b. Include instructions on start-up, operation, and maintenance.
c. Manufacturer's instructions for testing and adjusting switches and circuit breakers.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Perform all work in compliance with the following:
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

B. Testing Agency Qualifications
1. Member of NETA.
2. Acceptable to authorities having jurisdiction.
3. Field Supervisor currently certified by the NETA.

C. Product Selection for Restricted Space
1. Drawings indicate maximum dimensions for enclosed switches and circuit breakers.
2. Comply with indicated maximum dimensions.

1.7 MAINTENANCE

A. Extra Materials: Provide extra materials described below:
1. Match products installed.
2. Packaged with protective covering for storage.
3. Identified with labels describing contents.
4. Fuses: Provide 3 fuses of each size used on project.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
1. Provide new and unused products of current manufacture.
2. Provide products free from defects affecting performance.
3. All units of the same type must be from the same manufacturer.

B. Listing and Labeling
1. Provide UL listed and labeled products.
2. Provide products listed and labeled by an approved independent NRTL.
3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.
4. Provide a service equipment label on all switches and circuit breakers used as a service disconnecting means.

2.2 MANUFACTURERS

A. Subject to compliance, provide products by one of the following:

1. Cutler-Hammer.
2. Square D Company.
3. Or approved equal.

2.3 ENCLOSED SWITCHES

A. General
1. NEMA KS 1, UL-98.
2. Heavy duty safety switch.
3. Quick make, quick break mechanism.
4. Switch blades visible in OFF position with door open.
5. High conductivity copper current carrying parts and silver tungsten switch contacts.
6. Rated for 60 and 75 degree Celsius wire.

B. Operating Handle
1. Handle down in the off position.
2. Pad-lockable in off position with up to three padlocks.
3. Interlocked with cover to prevent opening cover with switch in closed position.
4. Inconspicuous interlock defeat mechanism.

C. Fusible Switches
1. Positive-pressure reinforced fuse clips.
2. Class R rejection type.
3. Fuses as shown and as specified in Division 26 Section “Overcurrent Protective Devices”.

D. Accessories
1. Neutral lug kit.
2. Ground lug.
3. Auxiliary contact.

2.4 ENCLOSED CIRCUIT BREAKERS

A. General
1. Molded case circuit breaker as shown and as specified in Division 26 Section “Overcurrent Protective Devices”.
2. NEMA AB 1.
3. Mechanical lugs sized for quantity, size, and type of conductors shown on the drawings.
4. Shunt trip coil
    a. Where shown on the drawings.
    b. 120 V energized from separate circuit.
    c. Set to trip at 75 percent of rated voltage.

B. Operating Handle
1. Handle down in the off position.
2. Pad-lockable in off position with up to three padlocks.
3. Interlocked with cover to prevent opening cover with switch in closed position.
4. Inconspicuous interlock defeat mechanism.

C. Accessories
1. Neutral lug kit.

2. Ground lug.
3. Auxiliary contact.

2.5 ENCLOSURES

A. General
1. Wet Locations: NEMA 250, Type 4X stainless steel.
2. Corrosive Areas: NEMA 250, Type 4X non-metallic.
3. Class 1 Hazardous Locations: NEMA 250 Type 7 cast aluminum.
4. All Other Locations: NEMA 250, Type 12 painted steel.

B. Finish: Manufacturer's standard paint factory applied before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
1. Examine surfaces that will receive the enclosed switches and circuit breakers.
2. Verify that the project has progressed to a point where this installation may begin.

B. Discrepancies
1. Immediately notify the Engineer in writing is any discrepancies are found.
2. Resolve all discrepancies before proceeding with installation.
3. Resolution must be acceptable to the Engineer.

3.2 PREPARATION

A. Surface Preparation
1. Carefully lay out the work in advance.
2. Perform any cutting, drilling, etc. without damaging the building surfaces or equipment.

B. Rough-in
1. Refer to equipment submittals for rough-in requirements.
2. Verify rough-in locations by field measurements.

3.3 INSTALLATION

A. General
1. Comply with the manufacturer's installation instructions.
2. Install enclosed switches and circuit breakers where shown.
3. Locations shown are approximate unless dimensioned.
4. Coordinate layout and installation with other construction, including conduit.
5. Maintain required workspace clearance.
6. Install motor disconnecting means within sight of the motor.
7. Provide suitable means for mounting enclosed switches and circuit breakers.
8. Remove temporary lifting means and blocking of moving parts.
9. Comply with mounting and anchoring requirements of in Division 26 section, "Seismic Controls for Electrical Work."

B. Connections

1. Tighten connectors and terminals according to manufacturer published torque values.
2. Where manufacturer torque values are not indicated, follow UL 486A-486B.
3. Provide effective and permanent grounding connections.

C. Identification
1. Identify field-installed conductors, interconnecting wiring, and components.
2. Provide warning signs as specified in Division 26 section, "Electrical Identification."
3. Label each enclosure as specified in Division 26 section, "Electrical Identification."

3.4 FIELD QUALITY CONTROL

A. Prepare for Acceptance Tests
1. Test insulation resistance for each enclosed switch and circuit breaker.
2. Test continuity of each line- and load-side circuit.

B. Testing
1. Do not start testing until enclosed switches and circuit breakers are installed and electrical circuitry has been energized.
2. Demonstrate product capability and compliance with requirements.
3. Perform visual and mechanical inspection and electrical test indicated in:
   a. NETA ATS, Section 7.5 for switches.
   b. NETA ATS, Section 7.6 for molded-case circuit breakers.
4. Certify compliance with test parameters.
5. Correct malfunctioning units on-site, where possible.
6. Retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Infrared Scanning
1. Perform an infrared scan of each enclosed switch and circuit breaker.
2. Perform scans after Substantial Completion, but before Final Acceptance.
3. Open or remove doors or panels so connections are accessible to portable scanner.
4. Perform a follow-up scan of each unit 11 months after date of Substantial Completion.
5. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
6. Provide calibration record for device.
7. Prepare certified report identifying equipment checked and describing scanning results.
8. Note deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Set field-adjustable circuit-breaker trip ranges.

3.6 CLEANING

A. General
1. After completing installation, inspect interior and exterior of enclosures.
2. Remove paint splatters and other spots.
3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
4. Repair exposed surfaces to match original finish.

END OF SECTION 26 2816

SECTION 26 2913

MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
1. Manual motor controllers.
2. Magnetic motor controllers.
3. Combination magnetic motor controllers.
4. Solid-state reduced voltage motor controllers.

B. Related Sections
1. Division 01 Section “Submittal Procedures”.
2. Division 01 Section “Operation and Maintenance Data”.
3. Division 26 Section “Basic Electrical Requirements”.
4. Division 26 Section "Basic Electrical Materials and Methods."
5. Division 26 Section “Grounding”.
6. Division 26 Section “Supporting Devices”.
7. Division 26 Section “Electrical Identification”.
8. Division 26 Section “Control Devices”.
9. Division 26 Section “Overcurrent Protective Devices”.
10. Division 26 Section "Motor Controllers."

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. Underwriter's Laboratory (UL)
1. UL 508, "Standard for Industrial Control Equipment."

C. National Electrical Manufacturers Association (NEMA)
1. NEMA 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."
2. NEMA ICS 2, "Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts."

1.4 DEFINITIONS

A. Abbreviations
1. AHJ: Authority having jurisdiction.
2. NRTL: Nationally recognized testing laboratory.
3. SPDT: Single pole double throw.

B. Seismic Withstand: When subjected to the specified seismic forces, seismic withstand means:
   1. The unit will remain in place.
   2. No parts will separate from the unit.
   3. The unit will be fully operational after the seismic event.

C. Finished Locations: The following are defined as finished locations:
   1. Areas with carpet or tile floors.
   2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
   3. Areas with tiled, plastered, or paneled walls.

D. Interior Locations: The following are defined as interior locations:
   1. Any location within the boundaries of the foundation of any building.
   2. Any location within the superstructure of other structures not classified as buildings.

E. Wet Locations: The following are defined as wet locations:
   1. All exterior locations.
   2. All interior locations below grade.
   3. All interior locations where wet materials are processed, pumped, transported, or stored.

F. Corrosive Locations: The following are defined as corrosive locations.
   1. All locations with chemical feed/transfer equipment
   2. All locations with chemical storage tanks
   3. All locations where chemical storage drums are located.

G. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
   1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information necessary to determine compliance.

B. Product Data
   1. Manufacturer’s technical product data sheets for all products specified in this section.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
   1. Materials List: Submit a list with quantities, manufacturer’s name, and catalog numbers.
   2. Dimensional Drawings: Submit dimensional drawings for all products.
   3. Wiring Diagrams: Submit wiring diagrams for all products.
      a. Show all components and features specified.
      b. Differentiate between factory installed and field installed wiring and components.

D. Quality Control Submittals
   1. Test Reports
      a. Factory test report: Submit results of the required factory test prior to shipment.
      b. Field test report: Submit certified copies of the field test reports.
   2. Manufacturer’s Instructions: Submit manufacturer's current installation instructions.
   3. Manufacturer’s field reports.

4. Training data.

E. Contract Closeout Submittals
1. Project record documents.
2. Operation and Maintenance (O&M) Data
a. Submit O&M manual prior to delivery of the products.
b. Comply with Division 01 Section “Operation and Maintenance Data”.
c. Include instructions on start-up, operation, and maintenance.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

1.7 MAINTENANCE

A. Extra Materials
1. Maintenance stock of fuses amounting to one unit for every installed unit.
2. One main control board for every three solid-state reduced voltage controllers provided.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
1. Provide new and unused products of current manufacture.
2. Provide products free from defects affecting performance.
3. Provide units of the same type all made by the same manufacturer.
4. Provide nameplates complying with Division 26 Section “Electrical Identification”.

B. Listing and Labeling
1. Provide UL listed and labeled products.
2. Provide products that have been listed and labeled by an approved independent NRTL.
3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 MANUAL CONTROLLERS

A. Manual Controllers
1. Sizes and ratings as indicated on the drawings.
2. Manually operated quick make, quick break toggle mechanism.
3. One piece melting alloy type thermal overload unit.
4. Controller inoperative when thermal unit removed.
5. Green pilot light.
6. Capable of being padlocked in the OFF position.

2.3 MAGNETIC CONTROLLERS

A. Magnetic Contactors
1. Three pole unless otherwise shown.
2. Sizes as shown.

3. NEMA ICS 2 and UL 508.
4. Integral NEMA sizes, minimum size 1.
5. Coil rated for 120 Volts unless otherwise shown.
6. Double break silver-alloy contacts.

B. Full Voltage Non-Reversing (FVNR) Magnetic Controllers
1. Magnetic contactor as specified above.
2. NEMA sizes as shown.
3. Solid-state overload relay as specified in article "ACCESSORIES" below.
4. Control power transformer as specified in article "ACCESSORIES" below.
5. Enclosure as specified in article "ACCESSORIES" below.

C. Full Voltage Reversing (FVR) Magnetic Controllers
1. Two magnetic contactors as specified above.
2. NEMA sizes as shown.
3. Contactors electrically and mechanically interlocked to prevent simultaneous closing.
4. Solid-state overload relay as specified in article "ACCESSORIES" below.
5. Control power transformer as specified in article "ACCESSORIES" below.
6. Enclosure as specified in article "ACCESSORIES" below.

D. Two-Speed Two-Winding Magnetic Controller
1. Two magnetic contactors as specified above.
2. NEMA sizes as shown.
3. Contactors electrically and mechanically interlocked to prevent simultaneous closing.
4. Two solid-state overload relays as specified in article "ACCESSORIES" below.
5. Control power transformer as specified in article "ACCESSORIES" below.
6. Enclosure as specified in article "ACCESSORIES" below.

2.4 SOLID-STATE CONTROLLERS

A. Solid-State Reduced Voltage Controllers (SSRV)
1. Provide types, ratings, and NEMA sizes as shown on the Contract Drawings.
2. Suitable for use with standard 3 phase squirrel cage induction motors.
3. Silicon controlled rectifiers (SCRs) for controlling motor voltages during acceleration.
4. On-board diagnostics with light emitting diodes (LEDs) to indicate fault conditions.
5. Isolated, convertible SPDT fault contact output for remote indication.
6. Adjustable current limit.
7. Solid-state overload relay as specified in article "ACCESSORIES" below.
8. Closed loop feedback system to maintain motor acceleration at constant rate.
9. Magnetic contactors as specified above.
    a. Bypass contactor.
    b. Input isolation contactor.
    c. Contactor for isolating power factor correction capacitors from SCRs.

2.5 COMBINATION CONTROLLERS

A. General
1. Motor controller, short-circuit protection, and disconnecting means.
2. Controller as described above (i.e., FVNR, FVR, SSRV).

B. Short-Circuit Protection

1. Fuse, molded-case circuit breaker, or motor circuit protector as shown.
2. As specified in Division 26 Section “Overcurrent Protective Devices”.

C. Disconnecting Means
1. External operating handle with an up-down motion and down position indicating OFF.
2. Lockable in the OFF position with up to three padlocks.

2.6 ACCESSORIES

A. General
1. Mount all accessories in the controller enclosure.
2. If an additional enclosure is required, obtain approval from the Engineer.
3. Construct any additional enclosures equal to the controller enclosure.
4. Provide all required interconnections between the enclosures.
5. Provide equipment nameplates complying with Division 26 Section “Electrical Identification”.

B. Solid-State Overload Relay
1. Current sensor in each phase.
2. Switch selectable for the specific motor full load amperes within the starter range.
3. Running overload protection with time-current characteristics closely paralleling that the motors heating damage boundary
4. Accurate to 2 percent.
5. Selectable overload trip class, 5, 10, 15, 20, and 30.
6. Phase failure protection.
7. Current unbalance trip setting adjustable from 10 to 50 percent.
8. Voltage unbalance trip setting adjustable from 5 to 20 percent.
9. Conformally coated to provide corrosion resistance.

C. Control Power Transformer
1. Provide a control power transformer for each motor controller.
2. Secondary voltage to match coil voltage specified above.
3. Provide control power transformers as specified in Section 260900, Control Devices.
4. Size transformer as required to provide adequate capacity to operate the following:
    a. Motor controller contactor coil.
    b. All other devices connected to the control circuit as shown.

D. Control Components
1. As specified in Division 26 Section “Control Devices”.
2. Type and quantity of control components as shown.
3. For spare controllers or where not shown, provide the following:
    a. Hand-Off-PLC selector switch.
    b. Elapsed time meter.
    c. Green run light.

E. Enclosures.
1. NEMA 250, Type 4X in corrosive locations.
2. NEMA 250, Type 4X in wet locations.
3. NEMA 250, Type 7 in Class I hazardous locations.
4. NEMA 250, Type 12 in all other locations.

2.7 MANUFACTURERS

A. Manufacturers: Subject to compliance, provide product manufactured by one of the following:
   1. Allen-Bradley.
   2. Cutler Hammer.
   3. Square D.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
   1. Inspect installed work prior to performing the work of this section.
   2. Verify that the project has progressed to a point where this installation may begin.

B. Material inspection.

C. Discrepancies
   1. Immediately notify the Engineer in writing of conditions detrimental to proper completion of the work.
   2. Correct all unsatisfactory conditions before proceeding with installation.
   3. Resolution must be acceptable to the Engineer.

3.2 PREPARATION

A. Surface Preparation
   1. Carefully lay out the work in advance.
   2. Perform any cutting, drilling, etc. without damaging the building surfaces or equipment.

B. Rough-in
   1. Refer to equipment submittals for rough-in requirements.
   2. Verify rough-in locations by field measurements.

3.3 INSTALLATION

A. General
   1. Conform to submittal data.
   2. Conform to arrangements indicated.

3.4 FIELD QUALITY CONTROL

A. Inspecting and adjusting
   1. Provide a manufacturer trained technician to inspect and adjust the equipment.
   2. Adjust motor overload trip setting and class to match motor nameplate.
   3. Adjust voltage and current unbalance settings to protect motor without nuisance trips.
   4. Adjust acceleration and deceleration times to prevent pressure surges in water lines.
   5. Make other adjustments to solid state controllers as required for proper operation.

B. After completion of all inspections, perform field testing.

C. Training

1. Train the Owner's personnel in the operation and maintenance of the products.
2. Complete all testing and adjustments before starting on training.
3. Provide for the services of a manufacturer's representative to perform the training.
4. Provide for a minimum of 4 hours of training for 6 people.

END OF SECTION 26 2913

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SECTION 26 2923

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General
   1. Drawings and general provisions of Contract.
   2. General and Supplementary Conditions.
   3. Division 01 Specification Sections.

B. Related Sections. The following sections contain requirements that relate to this section:
   1. Division 26 Section “Motor Control Centers”.
   2. Division 26 Section “Overcurrent Protective Devices”.
   3. Division 26 Section “Control Devices”.
   4. Division 40 Section “Instrumentation – General”.

1.2 DESCRIPTION OF WORK

A. Scope of Work.
   1. Extent of variable frequency drive work is shown on the drawings and specified herein.
   2. Provide all labor, materials, tools, and equipment necessary to perform the work.

B. Section Includes. Materials and equipment specified in this section include the following:
   1. Variable Frequency Drives (VFDs).
   2. Drive Accessories.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements
   1. National Electrical Code (NEC).
   2. All applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
   1. National Fire Protection Association (NFPA).
   2. Underwriters' Laboratories, Inc. (UL).
   3. Institute of Electrical and Electronic Engineers (IEEE).
   4. National Electrical Manufacturers Association (NEMA).

C. Qualifications
   1. Manufacturer: Firms engaged in the manufacture of VFDs for not less than 5 years.

1.4 SUBMITTALS

A. Product Data
   1. Manufacturer’s technical product data sheets for the VFD and all accessories.
   2. Delete or cross out all inappropriate or non-applicable information.

B. Shop Drawings
   1. Dimensional drawings showing enclosure size and arrangement of all components.
   2. Wiring diagrams in ladder logic form with terminal and wire numbers. Differentiate between factory installed and field installed wiring and components.
   3. Indicate job name, Owner, location, and date on all shop drawings.

C. Material list giving quantities, manufacturer's name, and catalog numbers.

D. Operation and Maintenance (O&M) Manual with the following:
   1. Maintenance data.
   2. Parts list.
   3. Troubleshooting guide.
   4. Product data
   5. Wiring diagrams.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs and accessories packaged in factory fabricated containers.

B. Store VFDs and accessories in a clean dry space.

C. Handle variable frequency drives and accessories carefully to avoid damage.

D. Return damaged units to equipment manufacturer and replace with new units.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES.

A. General
   1. Provide VFDs of sizes, ratings, and torque characteristics required by the driven equipment.
   2. Provide listed and labeled controllers and components.
   3. All drives on the project shall be the same manufacturer and series/class.
   4. Comply with the following:
      a. NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies,"
      b. NEMA Standard ICS 3.1, "Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems."
      c. NEMA Pub No.250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."
      d. UL 508C
   5. Provide drives suitable for use with standard squirrel-cage induction motors having a 1.10 service factor.
   6. Construction
      a. Full wave 6-pulse rectifier section.
      b. Direct current (dc) filter section
      c. Pulse width modulated (PWM) inverter section.

B. Features
   1. Designed to shut down without damage under the following conditions:
      a. Short circuit.

b. Overcurrent.
c. Over voltage.
d. Under voltage.
e. Loss of phase.
f. Over-speed.
g. Power unit over-temperature.

2. Selectable sensor-less vector or Volts per Hertz operating modes.
3. Multiple programmable stop modes including: ramp, coast, dc brake, ramp-to-hold, and s-curve.
4. Energy saving mode to automatically reduce output voltage to a lightly loaded motor.
5. Built-in process control algorithm.
6. Electronic motor overload protection.
7. Input line fuses.
8. Output voltage regulator.
9. Status LEDs for power and communications.
10. Door mounted operator interface with the following features:
    a. Membrane keypad with keys for the following:
        1) Drive programming.
        2) Numeric.
        3) Stop and stop.
        4) Automatic/Manual.
        5) Speed increase/decrease.
    b. Back-lit seven-line, 21 character LCD display.
11. Drive parameters stored in EEPROM and re-settable through the keypad.
12. Password security.
13. Process signal inverter to allow speed of drive to vary inversely with input signal.
14. Three programmable skip frequencies.
15. Capable of picking up a load spinning in either direction without tripping drive.
16. All components factory mounted and wired.
17. User programmable inputs and outputs (I/O).
    a. Minimum of two analog inputs, 4-20 mA, isolated.
    b. Minimum of two analog outputs, 4-20 mA, isolated.
    c. Minimum of six digital inputs, and two relay outputs.
18. Ethernet/IP communications.

C. Sizes and Ratings
1. Input Voltage: 480 Volt, three-phase, ±10%.
2. Input Frequency: 60 Hertz (Hz), ±3 Hz.
3. Displacement Power Factor: Between 1.0 and 0.95 lagging.
4. Efficiency: Greater than 96 percent.
5. Output Voltage: Three phase, variable from 0 to 460V.
6. Output Frequency: Variable from 6 to 400 Hz, minimum.
7. Speed Range: 10:1, step-less.
8. Acceleration/Deceleration Rate: Adjustable from 0 to 3600 seconds.
9. Minimum Frequency: Adjustable from 6 to 30 Hz.
10. Maximum Frequency: Adjustable from 60 to 120 Hz.
11. Current Limit: Adjustable from 100 to 150 percent.
12. PWM Carrier Frequency: Adjustable from 2 to 10 kHz.
13. Ambient Temperature Range: 0 to 40 degrees Celsius.
14. Relative Humidity Limit: 95 percent non-condensing.
15. Constant Torque / Heavy Duty rated (125% of installed motor FLA)

2.2 ACCESSORIES.

A. Control Components
   1. As specified in Division 26 Section "Control Devices," and as shown on the drawings.
   2. If not otherwise shown, provide a Hand-Off-PLC selector switch, fused control power transformer, green run pilot light, and red fault light.

B. Enclosures
   1. Configured as motor control center unit compartment where shown as part of a motor control center.
   2. Mount VFDs in NEMA Type 12 enclosures where not shown as part of a motor control center.
   3. Coat the enclosures with the manufacturer's standard color finish.

C. Drive Accessories
   1. Input line reactor, 3 percent impedance.
   2. Input isolation contactor.
   3. Output dV/dt filter.

2.3 EQUIPMENT/SYSTEM IDENTIFICATION

A. Provide equipment/system identification nameplates complying with Division 26, Section “Electrical Identification”.

2.4 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide VFDs by one of the following:
   1. Allen-Bradley Company.
   2. Eaton Corporation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. General
   1. Examine areas where VFDs are to be installed.
   2. Notify the Engineer in writing of conditions detrimental to proper completion of the work.
   3. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.2 INSTALLATION

A. General
   1. Install VFDs in accordance with the manufacturer's written instructions and recognized industry practices.
   2. Comply with requirements of NEC, UL and NEMA standards.
   3. Install fuses of sizes indicated in each fusible disconnect switch.
   4. Tighten connectors and terminals in accordance with manufacturer requirements, UL Standards 486A/486B, and the NEC.

B. Grounding
   1. Provide equipment grounding connections for VFDs and enclosure as indicated.
   2. Tighten connections to comply with tightening torque specified in UL Standard 486A/486B.

C. Start-up and Programming
   1. Upon completion of the VFD installation, provide for the services of a certified factory service technician to inspect and approve the installation and to program and start-up the drives.
   2. Program the drive command, set-up, and motor parameter settings to match the requirements of the motor, the control diagrams and control descriptions.
   3. All drive communication programming shall be provided by the System Integrator under Division 40, Section "Instrumentation – General". Provide any information necessary to allow the System Integrator to perform the required programming. Programming shall include all network addressing and the reading from or writing to of a minimum of eight registers in each drive.

D. Testing
   1. Provide all equipment required for testing, start-up and performance verification.
   2. Testing shall be witnessed by the Engineer. The Engineer shall be notified at least 48 hours in advance of testing. The current and voltage and power factor shall be monitored at the motor control center or switchboard feeding the controller being tested. Data shall be collected for each motor at rated load and speed with all motors running at rated load and speed.
   3. Prior to energizing of motor controllers, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure manufacturer's requirements are met. Units not acceptable shall be replaced.
   4. Harmonic Testing. Testing shall be witnessed by the Engineer. The Engineer shall be notified at least 48 hours in advance of testing. The current and voltage harmonic distortion and power factor shall be monitored at the motor control center or switchboard feeding the controller being tested with a BMI Model 3030 harmonic analyzer or equal. Data shall be collected for each motor at rated load and speed with all motors running at rated load and speed. Sufficient data shall be collected to prepare a report to compare the harmonic content of the system to the calculated values in the analysis submitted in accordance with Part 1 of this specification.

3.3 FIELD QUALITY CONTROL

A. General
   1. Prior to energizing the drives, check the phase-to-phase and phase-to-ground insulation resistance levels with ground resistance tester to ensure that requirements are fulfilled.
   2. Prior to energizing, check circuitry for electrical continuity and for short circuits.
   3. Verify that direction of rotation of each motor is correct.

B. Operational Demonstration
   1. Upon completion of installation of the VFDs, energize drive circuitry and demonstrate proper functioning of the equipment in accordance with requirements.
   2. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

3.4 TRAINING

A. General
   1. Provide for the services of a manufacturer-trained and certified representative to train the Owner's personnel in the proper operation and maintenance of the VFDs.
   2. Provide training for a minimum of 6 people.
   3. Total training time shall be 4-hours minimum per person.

B. Topics covered shall include:
   1. Safety.
   2. Keypad/display interface.
   3. Programming, setup, and configuration.
   4. Operational indicators.
   5. Faults, diagnostic tools, troubleshooting, and preventive maintenance.

C. Provide documentation for each attendee including equipment manuals, drawings and schematics of equipment supplied for this project.

3.5 ADJUSTING AND CLEANING

A. Adjust operating mechanisms, where necessary, for free mechanical movement.

B. Touch up scratched or marred enclosure surfaces to match original finishes.

END OF SECTION 26 2923

SECTION 26 4300

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Summary: These specifications describe the electrical and mechanical requirements for a modular, high-energy surge protective devices (SPDs) to be located where shown on the drawings.

B. Related Sections include the following:
   1. Division 26 Section “Wiring Devices”.
   2. Division 26 Section “Switchboards”.
   3. Division 26 Section “Panelboards”.
   4. Division 26 Section “Motor Control Centers”.

C. Standards: The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. Underwriters Laboratories; UL 1449 3rd Edition 2009 Revision (effective 9/29/2009)
   2. Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.34, C62.41, C62.45)
   3. Institute of Electrical and Electronic Engineers 1100 Emerald Book
   4. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
   5. National Fire Protection Association (NFPA 20, 70, 75 and 780)

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Manufacturers shall submit independent test data from a nationally recognized testing laboratory verifying the following: life cycle testing, overcurrent protection, UL1449 3rd Edition, noise attenuation and surge current capacity. Failure to do so will result in product disapproval.

B. Equipment Manual: The manufacturer shall furnish an installation manual with installation, startup, and operating instructions for the specified system.

C. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer that show unit dimensions, weights, component and connection locations, mounting provisions, connection details and wiring diagram.

1.4 QUALITY ASSURANCE

A. Codes: Perform all work in compliance with NFPA 70, National Electrical Code (NEC) and all applicable federal, state, and local codes and regulatory requirements.

B. Manufacturer: The specified interconnect assembly shall be designed and manufactured in the USA by a qualified manufacturer of SPD products. The manufacturer shall have at least 5 years experience in the design, testing, and manufacturing of surge protective devices.

C. Installer: Minimum of 3 years successful installation experience on projects utilizing equipment similar to that required for this project.

D. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 PROJECT CONDITIONS

A. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
   1. Operating Frequency: 50 or 60 Hz.
   2. Operating Temperature: -40 to 140 deg F.
   3. Humidity: 0 to 95 percent, non-condensing.
   4. Operating Altitude: 0 to 18,000 feet above sea level.

B. Warranty: The manufacturer shall provide a (5) (10)-year full parts replacement warranty

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
   1. Liebert Corp.
   2. Thor Systems, Inc.
   3. Phoenix Contact.
   4. Current Technology.
   5. DEHN.
   6. Protection Technology.

B. The SPD terminals shall accommodate the wire sizes as shown on the drawings.

2.2 REQUIREMENTS

A. Performance Ratings:
   1. Surge Current Capacity – Service Entrance and main distribution panels shall be UL Listed Type 1 SPD with a 200 kA Surge Rating per Mode.

2. Surge Current Capacity –Branch panels shall be UL Listed Type 2 SPDs with a 100 kA Surge Rating per Mode.
3. UL 1449 Nominal Discharge Current: The UL 1449 Nominal Discharge Current Rating shall be 20kA.
4. Protection Modes: The SPD shall provide protection in all modes: L-N or L-L, L-G and N-G (where applicable). Note: L = Line, G = Ground, N = Neutral
5. UL 1449 Voltage Protection Ratings: The maximum UL 1449 listed surge ratings for each and/or all of the specified protection modes shall not exceed the following:

System Voltage	UL 1449 Second Edition SVR				UL 1449 3rd Edition VPR			
	L-N	N-G	L-G	L-L	L-N	N-G	L-G	L-L
120/240	400V	400 v	400 v	800 v	800 v	700 v	900 v	1200 v
120/208	400 v	400 v	400 v	800 v	800 v	700 v	900 v	1200 v
240			800 v	800 v			1200 v	2000 v
277/480	700 v	700 v	700 v	1500 v	1200 v	1200 v	1200 v	2000 v
480			1500 v	1500 v			2000 v	2000 v

B. Life Cycle Testing: The SPD shall be life cycle tested to withstand 10kA (8x20µs), 20kV (1.2x50µs), IEEE C62.41 Category C surge current with less than 5% degradation of clamping voltage. The service entrance and main distribution panel SPDs shall withstand a minimum of 15,000 Category C 10kA Surges per Mode. Branch panel SPDs shall withstand a minimum of 6,000 Category C 10kA Surges per mode.

C. Overcurrent Protection: Fusing: All surge suppression components shall be individually fused and rated to allow maximum specified surge current capacity with an interrupting rating greater than the available short circuit current. Devices that utilize a single fuse to protect two or more suppression paths are not excepted. Replaceable fusing is unacceptable. Overcurrent protection that limits specified surge currents is not acceptable. Where the avialable short circuit current is not shown, the fusing shall be rated for 200kAIC.

2.3 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. One set of Form C contacts, for remote monitoring of protection status.
9. Surge-event operations counter.
10. NEMA 4X Enclosure.

2.4 PANELBOARD SUPPRESSORS

A. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.

4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of Form C contacts for remote monitoring of protection status. Coordinate with building management system.
10. Surge-event operations counter.
11. NEMA 4X Enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. The installing contractor shall install the SPD with as short of conductors as practically possible and twist the SPD input conductors together to reduce conductor inductance. The contractor shall follow the SPD manufacturer's recommended installation practices as found in the installation, operation and maintenance manual and comply with all applicable codes. Type 2 SPDs shall be connected to circuit breakers or fuses as required by the SPD's UL Listing.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/486B.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
   2. Complete startup checks according to manufacturer's written instructions.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION 26 4300

SECTION 40 0513

PROCESS PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the Work of this Section, including but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Exposed, buried, interior and exterior process piping.

B. Piping associated with the following processes:
   1. All Water Treatment Process Piping
   2. All Process Waste Piping
   3. Compressed and Low Pressure Air Piping
   4. Membrane Cleaning System (MCS) Piping
   5. All chemical feed piping
   6. Sample water piping

C. Process piping excludes the following:
   1. Piping associated with HVAC systems.
   2. Piping associated with plumbing and sanitary waste systems.
   3. Storm drainage piping.
   4. Gutters and downspouts.
   5. Water distribution system.

1.3 QUALITY ASSURANCE

A. General: All materials shall be free from defects impairing strength and durability and be of the best quality for the purposes specified or shown on the Drawings. It shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected and be true to detail.

B. Manufacturer's Qualifications
   1. Provide piping and appurtenances that are the standard product in regular production by Manufacturers whose products have proven reliable in similar service for at least two years.
   2. Provide piping and appurtenances of the same type from a single manufacturer.
   3. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.
   4. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components

C. The Contractor shall be responsible for making all field measurements prior to installation of his work. Any deviations in measurements between the field conditions and the Drawings shall be immediately reported to the Engineer.

D. Testing
   1. Manufacturer's certified test results as defined for the type of pipe shall be stamped approved by the Contractor and forwarded to the Engineer as a Reference Submittal. No pipe shall be installed which does not meet the requirements of these Specifications.
   2. All pipe, joints, and fittings shall be pressure tested as required by this Specification for the type of pipe. The Contractor shall notify the Engineer or Owner, in writing, at least 48 hours prior to performing the tests.

E. All materials furnished under this Section shall have NSF 61 approval.

1.4 SUBMITTALS

A. Provide technical submittals in accordance with Division 01 Section “Submittal Procedures”, demonstrating piping and accessories conform completely to the requirements of this Section.

B. Product Data
   1. Catalog cut sheets and description of all items.
   2. Construction materials.
   3. Standard diameters, wall thicknesses and other pertinent dimensions of all sizes of piping and accessories.
   4. Support and anchor details with manufacturer's maximum recommended loads.
   5. Design calculations indicating support spacing requirements for all size pipe.

C. Shop Drawings
   1. Complete piping layout indicating type of pipe, diameter and location. Show dimensions from adjacent structure, equipment and other piping.
   2. Location of all pipe joints, sleeves, valves, and couplings.
   3. Location of all pipe supports and anchors.
   4. Details of pipe anchors, supports, couplings, and joints.
   5. Grooved joint couplings and fittings may be shown on drawings and product submittals, and shall be specifically identified by the manufacturer’s style or series designation.

D. Testing: Copies of all field test reports.

E. Contractor shall verify chemical compatibility of piping, solvents, gaskets, seals, o-rings, etc. for each chemical feed system. Provide chemical compatibility charts and manufacturer’s written verification of compatibility for each chemical feed system.

1.5 HANDLING, DELIVERY, AND STORAGE

A. General
   1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
   2. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.
   3. Interiors of piping shall be completely free of dirt and foreign matter.

PART 2 - PRODUCTS

2.1 AMERICAN IRON AND STEEL REQUIREMENTS

A. This project is being funded in part with loan and loan forgiveness funds from the Ohio EPA WSRLA Program and is subject to American Iron and Steel (AIS) requirements. See Division 00, Section "OEPA WSRLA Program Requirements."

2.2 PIPING

A. General
1. The outside of all piping, valves, and fittings shall bear the Manufacturer's standard marking for type, pressure, etc.
2. All pipe and fittings shall be equal to or better than the grade specified.
3. Whenever Specifications call for close bending or coiling, use Grade B pipe.
4. All piping material shall be new and free from defects and shall be subject to standard mill test before being shipped. No salvaged or used pipe shall be used.
5. Pipe shall be labeled.
6. Fittings shall have the Manufacturer's name or trademark legibly raised or cut into each piece, and shall bear the Manufacturer's standard marking for type, pressure, etc.
7. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
8. Victaulic grooved fittings and couplings and valves may be utilized in lieu of welded, threaded, or flanged joints as shown on the Drawings. Gasket selection and intended use shall be verified as suitable for the intended service as published in the manufacturer's latest literature. Installation shall be in accordance with the coupling manufacturer's latest published instructions.

B. Hardware
1. Unless indicated otherwise, provide hardware of the following materials for all piping/valve hardware (bolts, nuts, and washers).
   a. Exposed (painted): Zinc Plated.
   b. Exposed (unpainted): 304 SST.
   c. Buried: 316 SST or Cor-Blu.
   d. Submerged: 316 SST.
2. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the bolts.
3. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.

C. Ductile Iron Pipe (DIP or DI)
1. Pipe
   a. Standards
      1) Flanged: ANSI/AWWA C115/A21.15.
      2) Nonflanged: ANSI/AWWA C151/A21.51.
      3) Thickness Class: 53 (Unless noted otherwise on Drawings).
   b. Lining
      1) Cement-mortar lining (All piping, unless indicated otherwise in the piping schedule)
         a) ANSI/AWWA C104/A21.4.
      2) Glass Lining (where indicated in the piping schedule)
         a) Glass Lining: Vitreous material that is smooth, continuous and formulated to prevent the adherence of grease, scum and crystalline

metal salt deposits in sludge, scum and related process piping systems in wastewater and sewage treatment systems.

b) Provide lining consisting of two coats, separately applied and separately fired at a maturing temperature of approximately 1400 degrees F (760 degrees C) creating a molecular bond with the base metal and a total minimum lining thickness of 8-10 mils.

c) Lining minimum hardness: 5-6 on the MOHS scale.

d) Provide lining capable of withstanding an instantaneous thermal shock of 350 degrees F (195 degrees C) differential without crazing, blistering or spalling.

e) Provide lining capable of withstanding a strain of 0.001 inch/inch (0.025 mm/mm), the yield point of the base metal, without damage to the glass lining.

f) Provide lining resistant to corrosion of between pH of 3 to 10.

g) Fabricators: Custom-Fab or Engineer Approved Equal.

c. Grooved end pipe shall be Class 53 (min), with ends that comply with ANSI / AWWA C606.

d. Coating

1) Buried pipe: 1 mil asphalt coating, AWWA C151.

2) Exposed pipe to be painted: Factory prime coat compatible with finished coat system.

2. Joints

a. Types: As shown on the Drawings—grooved joints are acceptable at locations where flanged joints are shown on the drawings. If not designated, use grooved or flanged joints for exposed piping and mechanical joints for buried pipe. Use grooved joints upstream and downstream of flow meters.

b. Flanged

1) Ductile iron, ANSI A21.10.

2) Bolt Circles and Bolt Holes: Class 125.

3) Gaskets: 1/8 inch EPDM full faced.

c. Grooved

1) ANSI/AWWA C606

2) Grooved joint couplings shall consist of two or more ductile iron housings to ASTM A536.

3) Gaskets: FlushSeal pressure responsive gasket to ASTM D2000.

4) Housing: Ductile Iron with coal tar epoxy coating (min 3 mils).

5) Bolts and nuts: 316 SST.

6) Basis of Design: Victaulic Style 31.

d. Mechanical or Push-on

1) ANSI A21.11.

2) Gaskets: plain tipped.

e. Restrained

1) Provide restrained joints on all buried pipe joints.

2) Restraining wedges shall be made of ductile iron; conform to ASTM A536.

3) Restraint at pipe joints (≥ 24-inch):

a) TR Flex by US Pipe.

b) Super-Lock or Restrained Tyton Joint by Clow.

c) Flex-Ring or Lok-Ring by American Cast Iron Pipe Company.

4) Restraint at pipe joints (< 24-inch):

a) All products acceptable for pipe ≥ 24-inch

b) Flex-ring by US Pipe.

c) Lok-Ring by American Cast Iron Pipe Company.

3. Fittings
   a. Types: As shown on the Drawings—grooved fittings are acceptable at locations where flanged fittings are shown on the drawings. If not designated, use flanged fittings for exposed piping and mechanical fittings for buried pipe.
   b. Flanged: ANSI/AWWA C110/A21.10.
   c. Grooved
      1) Comply with ANSI A21.10 /AWWA C110 for center to end dimensions, and ANSI A21.10 /AWWA C110 or AWWA C153 for wall thickness, with ends to AWWA C606.
      2) Basis of Design: Victaulic AWWA Fittings.
   d. Mechanical joint
      1) Full body ANSI/AWWA C110/A21.10 or short body ANSI/AWWA C153/A21.53.
   e. Pressure rating: 250 psi minimum.
   f. Coating and lining: Identical to connecting piping.
   g. Base tees and bends: Drill and furnish with anchor bolts. Machine when used as pipe kicker.
   h. Restrained
      1) Provide restrained joints on all buried pipe fittings.
      2) Restraining wedges shall be made of ductile iron; conform to ASTM A536.
      3) Provide a full length of pipe on both sides of the fitting.
      4) Restraint at fittings and valves
         a) Megalug by EBAA Iron Sales.

D. Prestressed Concrete Cylinder Pipe (PCCP)
   1. Prestressed concrete cylinder pipe and fittings shall be manufactured by Thompson Pipe Group, Grand Prairie, TX or equal.
   2. Unless otherwise specified, the design materials and workmanship for pipe shall conform to the requirements of AWWA C301. Core and coating thickness for pipe shall be as specified in AWWA C301.
   3. Design Conditions
      a. Pipe shall be designed in accordance with the AWWA C304 Standard, using the following design conditions; these conditions shall also be used in designing fittings that include a Portland cement mortar interior and exterior coating of the steel cylinder:
      b. Pipe shall be designed for an external live loading, including impact, equal to AASHTO H-20 loading with earth cover as shown
      c. Service Conditions:
         1) Liquid Service: Water
         2) pH range of contents: 6.0 to 8.5
         3) Design working pressure: 40 psi.
         4) Design transient pressure: 56 psi.
         5) Field test pressure shall be 50 psi.
         6) Pipe overburden and trench bedding condition: as shown on Drawings.
   4. The pipe core shall be produced by the centrifugal method or the vertical casting method.
   5. Materials
      a. Cement shall be Type II and shall be in accordance with ASTM C150.
      b. Mortar coating shall consist of one part cement to a maximum of three parts fine aggregate by weight. Rebound not to exceed one fourth of the total mix weight may be used provided the rebound is treated as fine aggregate.

c. Wire shall be a minimum of No.6 gauge and shall meet the requirements of ASTM A648, Class III. Wire of a class strength greater than Class III will not be permitted.
d. Steel cylinders shall be No. 16 gauge minimum thickness and shall be hot rolled.

6. Fittings
   a. Steel thickness of all fittings shall be designed in accordance with Chapter 8 of the AWWA M9 Manual. Fittings shall be designed for the same conditions as the adjacent pipe.
   b. Fabrication of the fittings shall be as per AWWA M9 manual and C301.
   c. Interior and exterior concrete/mortar coating shall be as per AWWA C301.
7. Joints
   a. Bell and spigot joint rings shall be steel, self-centering type, and otherwise specified in AWWA C301. Surfaces of the joint rings that will be exposed after fabrication is complete shall receive a zinc metalized coating of 4 mils thickness (0.004").
   b. Provide restrained joints by field welding joints or by mechanically restrained joints.
   c. The rubber gaskets shall be in accordance with AWWA C301 and shall be designed and manufactured so that the completed joint will withstand an internal water pressure in excess of the highest pressure to which the pipe will be subjected without showing any leakage by the gasket or displacement of it.
   d. Bell and spigot wall fittings shall be the manufacturer's standard design. Wall fittings shall be supplied with adequate bracing to keep them round and true during transportation and installation.

E. PVC Pipe and Fittings
1. Pipe:
   a. Schedule 80.
   b. Provide standard lengths of pipe sizes 10-inch and larger, beveled at each end by the pipe manufacturer.
2. Material:
   a. Type I, Grade I (Class 12454) conforming to ASTM D 1784.
3. Nipples:
   a. Short nipples shall be the same as the PVC pipe.
4. Fittings:
   a. Fittings shall be schedule 80 and shall conform to ASTM D 2464 for threaded fittings 6-inches and smaller and ASTM D 2467 for socket-type fittings 8-inches and smaller. For threaded fittings larger than 6-inches and for solvent welded fittings larger than 8-inches the fittings shall be schedule 80 per the manufacturer's standards. All fittings shall successfully pass the required pressure test. All fittings shall be manufactured in the USA by an ISO 9002 manufacturer.
5. Flanges:
   a. PVC flanges shall be made of the same material as the pipe. Flanges shall match the bolt pattern of ANSI B16.5, Class 150. Flanges shall be flat face.
   b. Gaskets shall be full faced, low torque, molded EPDM with dual concentric, convex sealing rings (and PTFE bonded to the rubber). The dimensions shall comply with 150# ANSI B16.5 drilling.

6. Unions
    a. Unions shall have socket-type ends, EPDM o-rings (unless noted otherwise), and shall be schedule 80. Material shall be Type 1, Grade I (Class 12454) per ASTM D 1784.
    b. Provide Unions at connections to equipment, valves, and other accessories to facilitate equipment removal.
7. Joints
    a. Pipes less than 8-inch diameter:
        1) Pipe and fitting joints shall be socket welded.
        2) Screwed joints that are necessary to match up to threaded valves or fittings shall be made up with Teflon Tape only.
    b. Pipes 8-inch diameter and larger:
        1) Grooved Joints.
        2) Grooved joint couplings shall consist of two or more ductile iron housings to ASTM A536.
        3) Gaskets: EPDM (Grade E).
        4) Housing: Ductile Iron orange enamel coating.
        5) Bolts and nuts: 316 SST.
        6) Basis of Design: Victaulic Style 357 coupling with PGS-300 groove profile.
    c. Connections to valves, pumps, and equipment:
        1) Provide flanges. Flanged joints shall be made with solvent welded PVC flanges.
8. Solvent Cement:
    a. IPS Corporation Weld-On 724 without exception.
9. Threaded ends:
    a. Taper pipe threads. All threaded female fittings shall be 316 stainless steel reinforced.
10. Manufacturer
    a. Pipe: Harvel or equal.
    b. Fittings: Spears or equal.

F. Polyvinyl Chloride Pipe (PVC) C900
1. Pipe: Conform to AWWA C900.
2. Dimension Ratio: DR-14 (unless noted otherwise on Drawings).
3. Pressure Class: 300 psi (unless noted otherwise on Drawings).
4. Joints: Flexible elastomeric, conform to ASTM D3139.
5. Gaskets: Conform to ASTM F477.
6. Fittings: Fully restrained ductile iron.
7. PVC Resin: Meet or exceed cell class 12454 as defined in ASTM D1784.
8. Pipe shall be homogeneous throughout; free from voids, cracks, inclusions or other defects. Surfaces shall be free from nicks, scoring, scratches, and other blemishes.
9. Color: Green
10. Manufacturer/Product name: JM Eagle/Blue Brute or equal.

G. Polyvinyl Chloride Pipe (PVC) D3034/F679
1. Pipe: Conform to ASTM D3034/F679.
2. Dimension Ratio: DR-26 unless otherwise noted on Drawings.
3. Pressure Class: PS115 unless otherwise noted on Drawings.
4. Joints: Flexible elastomeric, conform to ASTM D3212.
5. Gaskets: Conform to ASTM F477.
6. PVC Resin: Meet or exceed cell class 12364 as defined in ASTM D1784.

7. Pipe shall be homogeneous throughout; free from voids, cracks, inclusions or other defects. Surfaces shall be free from nicks, scoring, scratches, and other blemishes.
8. Color: Green
9. Manufacturer/Product name: JM Eagle/Ring-Tite PVC Gravity Sewer or equal.

H. High Density Polyethylene (HDPE)
1. Pipe: Conform to AWWA C901/906.
2. Dimension Ratio: DR-17 (unless noted otherwise on Drawings).
3. Pressure Class: 125 psi (unless noted otherwise on Drawings).
4. Joints: Heat fusion per ASTM D2657.
5. Resin: PPI TR-4 PE 4710, per ASTM D3350 Cell Class 445574 C/E.
6. Color: Black with green stripes.
7. Manufacturer/Product name: JM Eagle or equal.

I. Dual Wall Corrugated High Density Polyethylene (DWC-HDPE)
1. Pipe: Conform to ASTM F2648.
2. Joints: Soil tight bell and spigot, conform to AASHTO M294, or ASTM F2306.
3. Gaskets: Conform to ASTM F477
4. Resin: Cell classification 435420C (ESCR Test Condition B), as defined in ASTM D3350 except carbon black content should not exceed 4%.
5. Manufacturer/Product name: Advanced Drainage Systems, Inc./N-12

J. Single Wall Corrugated High Density Polyethylene (SWC-HDPE)
1. Pipe: Conform to AASHTO M252.
2. Perforations: Conform to AASHTO M252 Class II.
3. Joints: Soil tight couplings, conform to AASHTO M252 or M294.
4. Fittings: Conform to AASHTO M252.
5. Gaskets: Conform to ASTM D1056 Grade 2A2.
6. Resin: Cell classification 424420C, as defined in ASTM D3350 except carbon black content should not exceed 4%.
7. Manufacturer/Product name: Advanced Drainage Systems, Inc./Single Wall Highway Pipe.

2.3 STAINLESS STEEL PIPE

A. All stainless steel pipe and fittings shall be fabricated from Type 304 stainless steel Schedule 10S sheet and plate.
1. Pipe
a. Pipe shall conform to ASTM A-312 and be die-formed or rolled true to dimension and round within the applicable ANSI Standard. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe.
b. Fittings shall conform to ASTM A-403-WP in accordance with B16.9.
c. Longitudinal seams on pipe and fittings shall be welded by the GTAW, PAW, FCAW, SAW, or the SMAW methods. Filler metal, if utilized, shall be of same composition or superior to the pipe and fittings material.
d. Weld deposit at the seams shall have a slight crown on both sides of the weld and no cracks or crevices shall be allowed. Excessive weld deposits, slag, weld spatter and projections into interior of pipe shall be removed by grinding. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16 inch.

e. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard.
f. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard. Roll or Cut grooved as appropriate to the pipe material, wall thickness, pressure, size and method of joining.
g. For pipe sizes 2" and smaller, ASTM A312, Schedule 10S, stainless steel pipe with plain ends may be used in applicable piping systems with Vic-Press couplings and fittings.
h. Schedule 5S and 10S stainless steel pipe shall be roll grooved using a Victaulic grooving tool equipped with RX roll sets, specifically designed for stainless steel pipe.

2. Fittings
   a. Fittings shall be butt weld type per ASTM-A-403WP and manufactured in accordance with ANSI B16.9. All fittings shall be of the same pressure rating and grade material as the pipe.
   b. Fittings three inches and smaller shall be threaded conforming to ASTM-A-182 forged, Class 3000# and manufactured to ANSI B16.11.
   c. Fittings for buried or submerged pipe larger than three inches shall be butt-welded, conforming to ASTM-A-403WP, same pressure rating and material as the pipe and manufactured to ANSI B16.9.
   d. Fittings for above ground or exposed pipe larger than three inches shall be butt-welded or flanged, conforming to ASTM A 403 WP.
   e. Grooved End Fittings:
      1) Fittings shall be manufactured of stainless steel conforming to ASTM A-403, WPW, WPW/S9, or CR/S9, or shall be fabricated from stainless steel pipe conforming to ASTM A312, with factory grooved ends. Fittings shall be type 316.
      2) For NPS 2-inch and smaller, Schedule 10S stainless steel pipe may be used with precision, cold drawn, austenitic stainless steel fittings, complete with elastomer O-ring seals and suitable for working pressure of 500 psig. Basis of Design: Victaulic Vic-Press for Schedule 10S pipe.

3. Joints
   a. Joints for pipes three inches and smaller shall be threaded, grooved or socket welded, same material as the pipe, 3,000 pound WOG, conforming to ANSI B16.11.
   b. Joints for buried or submerged pipe larger than three inches shall be butt-welded.
   c. Joints for aboveground or exposed pipe larger than three inches shall be grooved or butt-welded except where flanges or grooved end joints are shown on the Drawings.
   d. Grooved
      1) Couplings shall consist of two ASTM A536 ductile iron housings or ASTM A351, Grade CF8M, stainless steel housings.
      2) Rigid Type: Housing key shall engage the bottom of the groove. Victaulic Style 89 (DI) and Style 489 (SS).
         a) AGS series two-segment couplings with lead-in chamfer on housing key and wide-width FlushSeal gasket. Victaulic Style W89.
      3) Flexible: Victaulic Style 77S.
   e. Split Sleeve Couplings
      1) Couplings shall consist of a double-arched rolled stainless steel housing, with closure plates and two elastomer O-ring seals. Couplings shall be Victaulic Style 230S Non-Restrained (Depend-O-Lok ExE); 231S

Expansion (Depend-O-Lok FxE); and Style 232S Restrained (Depend-O-Lock FxF).

4. Flanges
   a. Provide weld-neck flanges conforming to ANSI B16.5 for piping three inches and smaller to connect to flanged valves, fittings, or equipment. Provide slip-on flanges for piping larger than three inches. Provide blind flanges at dead end connections and where shown on the Drawings.
   b. Flanges shall be Class 150 per ANSI B16.5
   c. Provide full-face gaskets for flat faced flanges. Provide ring gaskets for raised face flanges. Gaskets shall be composed of asbestos with rubber binder, 1/8-inch thick, Johns-Manville No. 60, John Crane Co. "Granite", or equal for high temperature air service and shall be constructed of EPDM for ambient temperature water service.

2.4 CHEMICAL FEED TUBING

A. Braid Reinforced PVC Tubing
   1. Chemically resistant, flexible, high-dimensional stability and long-term strength.
   2. Working Pressure: 100 psi min. at 70 degree F
   3. Fittings: Barbed type, made of polypropylene, fastened with 316 SST hose clamps.
   4. Support: Tubing to be supported by schedule 80 PVC carrier piping. See details on the drawings. Carrier piping to be supported hardware and in accordance with Division 40, Section “Pipe Supports”.
   5. Manufacturer
      a. Tubing: New Age Industries Nylobrade or Engineer Approved Equal.
      b. Fittings: New Age Industries Thermobarb or Engineer Approved Equal.
   6. Spare Tubing:
      a. For each size diameter tubing provided, Contractor shall provide 1,000 LF of spare tubing.

2.5 PROCESS PIPE INSULATION

A. Process piping insulation is required at the following locations:
   1. All above grade exterior process piping.

B. Pipe Insulation, Non-flexible:
   1. Techlite 379 Series with PVC film jacket.
   2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
   3. Apply to the following piping in thickness indicated:
      a. Process piping (40 – 60 deg F):
         1) 1-1/4 inch and smaller — 1/2 inch
         2) 1-1/2 inch and larger — 1 inch
      b. Process piping (below 40 deg F):
         1) 3/4 inch and smaller — 1/2 inch
         2) 1 inch to 6 inch — 1 inch
         3) 8 inch and larger — 1-1/2 inch

2.6 PROCESS PIPE HEAT TRACING

A. Process piping shall be heat traced where indicated on the drawings. Heat tracing shall be in accordance with Division 40, Section “Process Piping Heat Tracing”.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Piping shall be installed in a manner to permit easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
2. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
3. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
4. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
5. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the runouts of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
6. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
7. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
8. Pipe size reductions shall be made with factory-fabricated eccentric reducers, concentric reducers, or reducing fittings and shall be installed not to cause pocketing or inhibit the flow of the material.
9. Install shut-off valves or cocks with unions on all connections to equipment and on each side of traps and control valves as required for ease of proper servicing and maintenance.
10. Unless otherwise indicated, the discharge from pressure-and temperature-relief valves and equipment drains shall be piped to the nearest floor or hub drain, installed with an approved air gap as required, and arranged for safe discharge.
11. No pipe shall penetrate any structural member without the written approval of the Engineer. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the Engineer.
12. Flanges and Gaskets
    a. Where forged steel flanges are to be bolted to cast iron flanges, a smooth or flat-face forged steel flange with a full-face gasket shall be used.
    b. All gaskets, other than teflon envelope or full-face, shall be of the flat ring type, with the outside diameter of the gasket extending to the edge of the bolts.
    c. Gaskets for all joints shall have an inside diameter equal to the outside diameter of the pipes on which they are to be used to ensure that no portion of the gasket will project into the ports of valves, pipe, or fittings.
    d. The dimensions of all gaskets shall conform to ANSI Standard B-16.21 for nonmetallic gaskets.
13. Provide flanged coupling adapters as necessary to accommodate ease of piping installation according to Contractor's layout plan.
14. Installation shall include all rough-in and final connections to equipment and services as provided in the Contract Documents, for the services and equipment to be functional.

B. Cross Connections and Interconnections: No devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply

and any source of nonpotable water such as a drainage system, a soil pipe, a waste pipe, or where the water may be chemically treated.

3.2 PIPE EXPANSION CONTROL: INSTALLATION

A. General
1. Install expansion loops or joints as required, to limit strain and movement of the piping.
2. All loops shall be cold sprung when installed.
3. Install conforming manufactured guides for each loop and joint to maintain the proper pipe alignment and minimize undue stresses on the piping and joints.
4. All mechanical joints and guides shall be installed in accordance with the Manufacturer's recommendations.
5. Install conforming manufactured pipe anchors at the midpoint between loops and joints. Installation and design shall be subject to the approval of the Engineer or Owner.
6. Manufacturer shall be held responsible for the proper capacity of the joints, with a minimum 25% allowance beyond the anticipated expansion and contraction in the piping.

B. Polyvinyl Chloride (PVC) Pipe: Provide expansion joints in straight piping runs over 50 feet and at least every 50 feet. Shall be Proco Series 261 or equal based on Chemical compatibility.

3.3 EXPOSED PIPING: INSTALLATION

A. General
1. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping and supports.
2. Painting of piping is specified elsewhere in the Contract Documents.
3. Install straight runs true to line and elevation.
4. Install vertical pipe plumb in all directions.
5. Install piping parallel or perpendicular to building walls. Piping at angles and 45 deg runs across corners shall not be accepted unless specifically shown.

B. Joints
1. General
   a. Make joints in accordance with the pipe Manufacturer's recommendations and the requirements below.
   b. Cut piping accurate and square. Assemble without forcing or springing.
   c. Ream all pipes and tubing to full inside diameter after cutting. Remove sharp edges on end cuts.
   d. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.
   e. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
   f. Thoroughly wire-brush, wipe clean and dry all spigot mating surfaces immediately before pipe is installed.
2. Threaded Joints
   a. Use standard righthand tapered full depth threads on steel piping.
   b. Apply before installation an approved joint compound to the male threads only.
   c. Leave three pipe threads maximum exposed at each connection.
3. Grooved Joints:
   a. Install in accordance with the manufacturer’s latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and

roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for Contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices are being followed. Contractor shall correct any deficiencies found.

4. Solder Joints
   a. Ream or file pipe to remove burrs.
   b. Clean and polish contact surfaces of joints
   c. Apply flux to both male and female ends.
   d. Insert end of tube full depth into fitting socket.
   e. Heat joint evenly.
   f. Form continuous solder bead around entire joint circumference.
5. Flanged Joints: Use hexagon head nuts and bolts. Assemble flanged joints with gaskets and gasket compounds in compliance with the applicable material specifications. Tighten flange bolts evenly.
6. Plastic Pipe Joints: Comply with Manufacturer's recommendations.

C. Unions
1. Install dielectric unions where dissimilar metals are connected except at bronze or brass valves installed in ferrous piping.
2. Provide a union downstream of each screwed end valve.
3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

D. Eccentric Reducers: Use eccentric reducers where shown and where air or water pockets would occur in mains because of reduction in pipe size.

E. Transitions between Types of Pipe: Provide all necessary adapters, specials and connector pieces when connecting different types and sizes of pipe or connecting pipe furnished by different Manufacturers.

F. Restraints, Supports and Thrust Blocks
1. Install restrained joints as shown, specified, recommended by Manufacturer, or otherwise required.
2. Provide concrete and metal cradles, collars, kickers, and blocks as indicated.

G. Expansion Coupling
1. Install expansion couplings in tension to facilitate their removal.
2. Set stretcher bolts for maximum allowable elongation of expansion coupling as recommended by the Manufacturer.

H. Adjustment: Adjust all parts and components as required to provide correct operation.

I. Hangers, Supports and Attachments: Installation: Refer to Division 40 Section "Pipe Supports".

J. Identification of Piping: Paint, identify contents of piping and flow direction, and coordinate color coding of both insulated and non-insulated piping with Division 09 Section "High Performance Coatings".

3.4 BURIED PIPING: INSTALLATION

A. Conform to the applicable requirements set forth in Division 33 Section "Buried Piping Installation".

3.5 PVC AND CPVC PIPE INSTALLATION

A. General
1. Do not install pipe when the temperature is below 40 deg F or above 90 deg F. Store loose pipes on racks with a minimum support spacing of 3 feet. Provide shade from direct sunlight for pipe stored outdoors or installed outdoors until the pipe is filled with water.
2. Store fittings indoors in their original cartons.
3. Store solvent cement indoors or, if outdoors, shade from direct sunlight. Do not use solvent cements which have exceeded the shelf life marked on the storage container.
4. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section as a complete cylinder.

B. Installation
1. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it.
2. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings.
3. Bevel solvent welded pipe ends as recommended by the pipe manufacturer.

C. Solvent Welded Joints
1. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air for at least one hour to the same temperature conditions as the pipe.
2. Wipe away loose dirt and moisture from the ID and OD of the pipe end and the ID of the fittings before applying solvent cement. Do not apply solvent cement to wet surfaces.
3. Make up solvent welded joints per ASTM D 2855.
4. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads or pressures.

D. Flanged Joints
1. Lubricate stainless steel bolt threads with specified materials before installation.
2. Tighten bolts on flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be as shown in the following table:

Pipe Size (inches)	Final Torque (Ft-Lb)
1/2 – 1-1/2	10-15
2-4	20-30
6-8	33-50
10	53-75
12	80-110
14-24	100

E. Threaded Joints
   1. Cut threaded ends on pipe to the dimensions of ANSI B2.1. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe holddown methods, saw cutting blade size, and saw cutting speed.
   2. Pipe or tubing cutters shall be specifically designed for use on plastic pipe.
   3. If the holddown vise is used when pipe is cut, insert a rubber sheet between the vise jaws and the pipe to protect from scratching the pipe.
   4. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.
   5. Not more than three threads shall remain exposed after installation.
   6. All joints shall be wrapped with Teflon tape.

3.6 SLEEVES: INSTALLATION

A. Provide and accurately locate all sleeves required under this Section. Set sleeves true to line, grade and position, plumb or level, and maintain as such during the work under other Divisions.

B. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.

C. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done as Work of this Section, with no change in the Contract Sum or the Date of Substantial Completion.

D. Sleeves shall not penetrate any structural member except as shown on the Drawings.

E. Provide 8-inch clear space between sleeves unless otherwise indicated on the Drawings.

F. Sleeves shall be of the full thickness, with the exposed ends flush and smooth, with the structure in which they are installed.

G. Wherever water might get into the sleeve, the sleeves shall extend 1 inch above the finished surface and be made watertight. The exposed end shall be smooth and neatly finished.

H. On all piping passing through a sleeve, the piping insulation shall be continuous through the sleeve. The sleeve shall be sized to allow a 1 inch annular space between the sleeve and the bare pipe or insulation.

I. Sealing of Sleeves and Penetrations
   1. Where sleeves are embedded through cast-in-place concrete walls or slabs on or below grade, the joints between the concrete and the sleeve shall be sealed with a polyurethane sealer.
   2. Where sleeves pass through boxed out or cored openings in concrete walls or floor slabs on or below grade, a bonding agent shall be applied to the concrete surface and a nonshrink grout shall be installed between the concrete and the sleeves. After the grout has cured, the joints between the grout and the sleeves on both sides of the wall or floor shall be sealed with a polyurethane sealer.
   3. Where sleeves pass through exterior building walls above grade, the joints between the wall and sleeve on both sides of the wall shall be sealed with silicone sealer or the opening shall be sealed with silicone foam.

J. The 1 inch annular space around pipes passing through sleeves shall be filled with silicone foam having a minimum service temperature rating at least 15 deg F higher (8.3 deg C higher) than the temperature of the pipe service passing through it.

3.7 TESTING

A. General
1. All pipe lines shall be tested to prove tightness of the final assembly. The Engineer shall be given 24 hours notice before each test.
2. All tests required by governing authorities shall be satisfactorily made.
3. Provide all necessary testing apparatus, including gages, pumps, hoses, and fittings.
4. Repair and retest pipelines which fail to hold specified test pressure or which exceed the allowable leakage rate.
5. Test pressures specified apply at the lowest elevation of the pipeline section being tested unless otherwise noted.
6. The Contractor is responsible for all testing and shall pay all costs incurred during the specified testing.

B. Hydrostatic Pressure Testing
1. General
   a. Conduct hydrostatic pressure testing on all process piping in accordance with AWWA C600.
   b. Slowly fill section to be tested with water and expel all air. Install corporation cocks as necessary to remove air.
   c. Apply test pressure for two hours.
2. Exposed Piping
   a. Allow any concrete which may be affected by the testing to reach design strength before testing.
   b. Ensure that all supports and restraint protection are securely in place.
3. Buried Piping
   a. Place and compact backfill to at least the pipe centerline before testing, unless otherwise required or acceptable to the Engineer. Backfill and compact around all blocking before testing and as required to assure restraint by harnessed joints.
   b. Allow concrete for blocking to reach design strength before testing.
4. Test Pressure
   a. Piping connected to pump suction and discharge: 150% of specified maximum operating head of pump.
   b. Gravity flow ductile iron pipe: 150% of maximum static water head of pipe section being tested.
   c. Liquid chemical feed piping: 100 psi

C. Allowable Leakage: Leakage shall not exceed:

$$L = \frac{SD(P)^{0.5}}{133{,}200}$$

Where
L = Allowable leakage, gallons per hour.
S = Length of pipe tested, feet.
D = Nominal diameter of pipe, inches.
P = Average test pressure, psig.

3.8 CLEANING AND DISINFECTION

A. General
   1. All piping systems shall be cleaned and flushed out prior to operation. If it is necessary to place the system in operation by sections, then the cleaning shall be done by sections. Notify Owner prior to start of Work.
   2. Inspect inside of piping 24-inch diameter and larger and remove all debris, dirt and foreign matter.
   3. All piping, including equipment installed in connection with the piping, conveying liquids shall be filled and flushed several times to eliminate all debris and contaminants.
   4. Where pumps are installed, install temporary strainers ahead of pumps and circulate the medium through several cycles. The system shall be flushed out and the temporary strainers removed. Strainers shall have a free area of at least 3 times the cross sectional area of the attached pipe.
   5. Prior to turning over the Work, this Contractor shall remove and clean all strainers, traps, and dirt pockets.
   6. All process piping shall be pigged and flushed.

B. Disinfection
   1. Standard: AWWA C651 unless otherwise acceptable to the Engineer or Owner.
   2. Disinfect all potable water piping.
   3. Flush piping with water at 2-1/2 feet per second minimum velocity prior to disinfection.
   4. Water for flushing, testing and chlorination will be furnished by Owner at no cost to Contractor.
   5. Chlorine shall be supplied by Contractor.
   6. All other labor, material and equipment including chlorination taps and blow-off taps shall be furnished and paid for by the Contractor.
   7. Chlorine Concentration
      a. Maintain chlorine concentration between 50 and 100 parts per million for water entering the pipe.
      b. 25 parts per million minimum residual concentration shall remain after 24 hr retention period.
      c. Repeat the operation as necessary to provide complete disinfection.
      d. Provide two safe total coliform samples taken 24 hours apart prior to placing pipe in service. Provide results to Ohio EPA and the Engineer.

3.9 INSULATION INSTALLATION

A. Do not insulate piping until satisfactory completion of required pressure tests.

B. Apply insulation to clean, dry surfaces with pipe surfaces at room temperature.

C. Butt insulation firmly together with longitudinal and end joints sealed with compatible jackets, facings and adhesives as specified.

D. Apply adhesives, mastics and coatings per manufacturer's recommendations and as specified.

E. On cold surfaces where vapor barrier jackets are used, apply insulation with a continuous, unbroken vapor seal.
   1. Adequately insulate and vapor seal hangers, supports, and anchors that are secured directly to cold surfaces to prevent condensation.

F. Continue insulation through sleeves and wall and ceiling openings except insulation shall not continue through fire-rated (2-hour or greater) partitions, walls, floor-ceiling systems.

G. Insulate all fittings, valve bodies, flanges and other pipeline accessories.

H. At hangers and bracing, install in accord with Division 40 Section “Pipe Supports”.

I. Contractors shall consult manufacturer's Technical Bulletins for detailed information on safety precautions in using all insulation products, polyurethanes, polyisocyanurates, and related materials. The data shall describe fire and other risks, safety in handling, toxicity, threshold limit values, physiological effects of inhalation and eye and skin contact, incompatibilities and other essential information regarding use. Obtain 6 copies for distribution and use at jobsite and for submittal with shop drawing submittals.

J. On piping, install with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge on hot piping.
   1. On cold piping, use self-sealing lap system or adhesive applied to both surfaces per manufacturer's recommendation.
   2. Do not staple cold piping.
   3. Butt adjoining sections of insulation tightly together and continue jacket by installing self-adhering butt strips over entire circumferential joint.

K. Installation of Insulation of Fittings
   1. For pipe sizes 2 inches and smaller, finish with mineral fiber cement to thickness of adjoining pipe insulation.
   2. Over 2 inches, insulate with mitered pipe insulation segments or preformed fiberglass fittings secured with vinyl faced insulation strapping tape or 20 ga galvanized annealed wire and finished with one coat of mineral fiber cement.
   3. After cement is dry, finish with Glass Fab and seal with Foster 30-36 adhesive.
   4. Prefabricated fitting covers approved for use at pipe fittings may be used instead of finishing method outlined above.
   5. Install in accordance with manufacturer's recommendations.

L. Cover all insulated piping exposed to weather with additional jacket of 0.016-inch smooth aluminum with moisture barrier.
   1. Apply aluminum jacket with 0.020-inch x 3/8-inch aluminum bands on 9-inch centers, minimum 2-inch lap joint.
   2. Protect fittings, valves, and specialties exposed to weather in like manner.
   3. Contractor option: Use Ceel-Co 300 Series plastic jacketing applied per manufacturer's recommendations.

M. Reinforce jackets on insulated piping in mechanical rooms and central plant less than 8 ft. above floor.
   1. Cover with 0.030 inch PVC jacket conforming to 25-50 fire requirements.

END OF SECTION 40 0513

SECTION 40 0523

PROCESS VALVES, GATES, AND ACCESSORIES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the Work of this Section, including, but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Valves, Gates, Actuators and Accessory Process Equipment

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Valves and accessories for a specific system, as covered in other sections. Valves not included in other Sections shall conform to this Section.

B. Valves associated with plumbing, interior potable water systems and heating normally installed by a mechanical contractor.

C. Division 09 Sections.

D. Division 26 - Electrical.

1.4 QUALITY ASSURANCE

A. The equipment manufacturer shall have been engaged in the manufacture of the equipment being supplied for the past 5 years.

B. All equipment shall be rated for the specified test pressure of the piping where it is connected. Refer to Division 40 Section “Process Piping”, for test pressures.

C. Manufacturer's Representative
   1. A manufacturer-trained and certified representative shall check the installation, supervise the initial start-up and operation, and instruct the Owner's personnel in the proper operation and maintenance for the valves listed below.
      a. Pneumatic pinch valves.
      b. Electrically activated butterfly valves.
   2. The manufacturer's representative shall spend a minimum of 8 hours on site performing these services.
   3. Return visits shall be made as required to accommodate the construction schedule until each valve is started and demonstrated to be operating properly. Return visits shall be at no expense to the Owner.

1.5 SUBMITTALS

A. Provide technical submittals in accordance with Division 01 Section “Submittal Procedures”, demonstrating that all equipment provided conforms completely to the requirements of this Section.

B. Product Data
   1. Catalog cut sheets and description of all items.
   2. Specific location of each item in the Project identified with Engineer's valve schedule number.
   3. Construction materials.
   4. Electric and control data.

C. Shop Drawings
   1. Detailed dimensional drawings indicating overall dimensions and required clearances of each size item with actuators mounted.
   2. Orientation of actuator.
   3. Elevations, weights and sizes of all gates.
   4. Cross-section drawings labeling all interior parts, including bearings, seals, and other mechanical parts.
   5. Diagrams indicating lubrication compartments and anchoring and mounting details.

D. Operation and Maintenance Manuals: Provide Operation and Maintenance Manuals in accordance with Division 01 Section “Closeout Procedures”.

1.6 HANDLING, DELIVERY AND STORAGE

A. Handling and storage instructions shall accompany each pump delivered to the site. Store all equipment in accordance with the manufacturer's instructions.

B. Power actuators shall be stored indoors, protected from precipitation.

1.7 REFERENCED STANDARDS

A. American Society of Mechanical Engineers (ASME); American Society of Testing and Materials (ASTM); American Water Works Association (AWWA).

PART 2 - PRODUCTS

2.1 AMERICAN IRON AND STEEL REQUIREMENTS

A. This project is being funded in part with loan and loan forgiveness funds from the Ohio EPA WSRLA Program and is subject to American Iron and Steel (AIS) requirements. See Division 00, Section “OEPA WSRLA Program Requirements.”

B. Attempts made by suppliers and/or manufacturer’s to intentionally avoid having to comply with the AIS requirements by changing the material of valve components from those specified (or other similar measures) will result in the submittal being returned with the disposition of Does Not Conform.

2.2 GENERAL

A. Valve schedule is shown on the drawings.

B. Connections: As shown on the Drawings, grooved joints are acceptable at locations where flanged joints are shown on the drawings. If not designated, use flanged or grooved joints for exposed valves and mechanical joints for buried valves.
   1. Flanged: ANSI B16.1, Class 125
   2. Mechanical joint: ANSI 21.11
   3. Grooved: ANSI/AWWA C-606

C. Bolts and Studs
   1. Exposed (painted): Zinc Plated.
   2. Exposed (unpainted): 304 SST.
   3. Buried: 316 SST or Cor-Blu.
   4. Submerged: 316 SST.
   5. Head: Hexagon for flanged, T-head for mechanical joint.
   6. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the bolts.
   7. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.

D. Labeling
   1. Manufacturer's name and working pressure cost in raised letters on valve body.
   2. Valve Tags: Provide 316 SST valve tags on each valve after valve is installed, with the following information clearly labeled:
      a. Valve number
      b. Direction to open
      c. Number of turns to open
      d. Pressure rating
      e. Function

2.3 VALVES

A. Butterfly Valve (BFV-AWWA)
   1. Description:
      a. AWWA C-504 type butterfly valve.
   2. Manufacturer/Model:
      a. Dezurik/BAW.
      b. Crispin.
      c. Pratt.
      d. Val-Matic.
   3. End Connection:
      a. Flanged, ANSI Class 150.
   4. Materials of Construction:
      a. Body:
         1) Cast Iron, ASTM A126 Class B
      b. Discs
         1) Cast 316 SST, ASTM A749, Type CF8M
      c. Shaft, Seating Edge, and Pin:
         1) 316 SST, ASTM A276
      d. Packing and Seat:
         1) EPDM.
      e. Torque Screw:
         1) 316 SST, ASTM A276

f. Set Screws:
1) 18-8 SST.
g. Plug:
1) Malleable Iron, ASTM A47-52 Grade 35018
h. Lower Journal Bearing:
1) PTFE

5. Valve Orientation
a. Any butterfly valve located immediately downstream of the discharge of any centrifugal pump with a vertical drive shaft shall have its shaft in a horizontal position.
b. Any butterfly valve located immediately downstream of the discharge of any vertical lift type pump should have its shaft in a vertical position.
c. Any butterfly valve which is located immediately downstream of any elbow should have its shaft located in the same plane as the elbow.
d. The valve disc should be installed with the shaft axis oriented so nonsymmetric profiles caused by pump discharge, elbows, or other causes of irregular flow do not impinge upon the valve disc in a nonsymmetrical manner about the valve shaft axis.

B. Butterfly Valve (BFV-SST)
1. Description:
a. Double offset stem and disc, high performance butterfly valve with zero leakage bi-directional shutoff to full rated pressure.
2. Manufacturer/Model:
a. Bray/Series 40.
b. Dezurik/BHP.
c. Engineer Approved Equal.
3. End Connection:
a. Wafer or Lug, ANSI Class 150
4. Pressure Rating:
a. 275 psig at Temperatures up to 100 degrees F
5. Materials of Construction:
a. Body and Disc:
1) Cast 316 SST, ASTM A351 GR CF8M
b. Stem and Taper Pins:
1) 17-4 PH SST, ASTM A564-Type 630
c. Disc Spacers, Bearing Assembly, Gland Ring, and Stud:
1) 316 SST, ASTM 276 with TFE and glass fabric bearing assembly liner
d. Gland Retainer and Seat Retainer Plate:
1) Cast 316 SST, ASTM A351 GR CF8M
e. Lock Washers, Hex Nut, Cap Screws, and Mounting Plate:
1) 18-8 SST
f. Gasket (between bearing assembly and locator plug):
1) PTFE

C. Butterfly Valve (BFV-Coated)
1. Description:
a. Resilient seat, high strength, one piece butterfly valve with coated disc and bi-directional bubble-tight shutoff.
2. Manufacturer/Model:
a. Bray/Series 30.

b. Dezurik
c. Engineer Approved Equal.

3. End Connection:
   a. Wafer or Lug, ANSI Class 150
4. Pressure Rating:
   a. 175 psig at Temperatures up to 100 degrees F
5. Materials of Construction:
   a. Body:
      1) Cast Iron, ASTM A126 Class B with Nylon 11 Coating
   b. Seat:
      1) EPDM
   c. Stem:
      1) 416 SST, ASTM A582
   d. Disc:
      1) Nylon 11 Coated Ductile Iron

D. Swing Check Valve (CV-Cast Iron)
1. Description:
   a. AWWA C-508 type check valve.
2. General:
   a. The valve shall be tight seating when closed, and when open provide full flow area through the valve equal to the pipeline diameter.
   b. The seating shall be by a resilient field replaceable ring on the valve disc contacting a stainless seat ring in the valve body.
   c. Valve shall be capable of being installed in the vertical.
   d. Valve shall include an air cushion closure control device.
3. Manufacturer/Model:
   a. APCO/CVS.
   b. Bray.
   c. Pratt.
4. End Connection:
   a. Flanged, ANSI Class 150.
5. Materials of Construction:
   a. Body, cover, disc, and disc arm:
      1) Ductile Iron ASTM A536 or Cast Iron A126 C1B.
   b. Body Seat:
      1) 316 SST with EPDM retaining ring.
   c. Seat retaining ring:
      1) 304 SST.
   d. Disc Seat:
      1) EPDM.
   e. Pivot Shaft:
      1) Type 303 SST, ASTM 582.
   f. Studs, bolts, nuts:
      1) 304 or 316 SST.

E. Check Valve (CV-SST)
1. Description:
2. Manufacturer/Model:
   a. Bray(Rite)/210.
   b. Prince.

c. Engineer Approved Equal.

3. End Connection:
   a. Wafer or Lug, ANSI Class 150
4. Materials of Construction:
   a. Body:
      1) Cast 316 SST, ASTM A351 GR CF78M
   b. Seat:
      1) EPDM
   c. Spacers:
      1) 316 SST, ASTM A479

F. Globe Valve (GLOBE-Conc.)
1. Manufacturer:
   a. Warren Controls, 5840 Series.
2. Function:
   a. Flow Control.
3. End Connection:
   a. Flanged, ANSI Class 300.
4. Materials of Construction:
   a. Body and Bonnet:
      1) Cast 316 SST (ASTM A351 GR CF8M)
   b. Stem, cage, plug, trim, and seat ring:
      1) 316 SST
   c. Lip:
      1) EPDM with PEEK bearings
5. Enclosure Blanket:
   a. Provide an insulating blanket wrap for the valve
6. Actuator:
   a. Type:
      1) Modulating, linear, industrial electrically actuated.
   b. Fail in place.
   c. Power Supply:
      1) 24 VAC/DC.
   d. Control Signal and Feedback:
      1) 4-20 mA.
   e. Cover:
      1) Polycarbonate
   f. Gear case material:
      1) Aluminum die casting, powder-coated (60 micron thickness)
   g. Enclosure Rating:
      1) IP65

G. Globe Valve (GLOBE-Bypass)
1. Description: Motor operated flow control valve.
2. Manufacturer/Model:
   a. Ross Valve
   b. Cla-Valve
   c. GA Industries
3. End Connection:
   a. Flanged, ANSI Class 150.
4. Pressure Rating: 250 psi.

5. Materials of Construction:
    a. Body and cover:
        1) Ductile Iron, ASTM A536.
    b. Disc Retainer & Diaphragm Washer:
        1) Cast Iron
    c. Disc Guide, Seat, and Cover Bearing:
        1) Bronze, ASTM B62.
    d. Disc and Diaphragm:
        1) Buna-A (with nylon reinforcement in the diaphragm).
    e. Stem, Nut, and Spring:
        1) 304 SST.
6. Controls
    a. Provide a modulating motorized operator for control of the valve via a 4-20 mA signal.

H. V-notch Ball Valve (BA-V-Notch)
1. Manufacturer/Model
    a. Bray(Flow-tek)/V-Control
    b. Dezurik.
2. End Connection:
    a. Flanged, ANSI Class 150.
3. Materials of Construction:
    a. Body, Ball, and Stem:
        1) 316 Stainless Steel.
    b. Seals and Seats:
        1) Tek-Fil.
4. Actuator: As specified in the valve schedule.

I. Ball Valve (BA-SST)
1. Description:
    a. One piece body, quarter turn, bottom entry blowout proof stem, SST ball valve.
2. Manufacturer/Model:
    a. Bray(Flow-Tek)/S40
    b. Engineer Approved Equal
3. End Connection:
    a. NPT Threaded
4. Pressure Rating:
    a. 1,000 psi WOG
5. Materials of Construction:
    a. Body and Body Insert:
        1) Cast 316 SST, ASTM A351 GR CF8M
    b. Ball and Stem:
        1) 316 SST, ASTM A479
    c. Seat, Thrust Washer, Stem Packing
        1) RPTFE
    d. Spring Washer:
        1) 301 SST
    e. Handle, Handle Nut, Locking Device, and Gland
        1) 304 SST
    f. Handle Sleeve
        1) Vinyl

J. Check Valve (CV-Thermoplastic)
   1. Description: Solid, thermoplastic construction type wafer check valve incorporating a single disc design suitable for either horizontal or vertical installations.
   2. Manufacturer/Model
      a. Asahi/Wafer Check Valve.
      b. Engineer Approved Equal.
   3. End Connection:
      a. Wafer, ANSI Class 150.
   4. Pressure Rating:
      a. 150 psig (85 psi for valves larger than 8")
   5. Materials of Construction:
      a. Body, Disc, Stopper, Shaft, Shaft Plug, and AV Bolt:
         1) H707 PVC, ASTM D1784 1245
      b. I-bolt:
         1) SS400.
      c. Spring:
         1) SWP-B W/ETFE Coating.
      d. O-ring:
         1) EPDM

K. Butterfly Valve (BFV-Thermoplastic)
   1. Description: Thermoplastic construction type butterfly valve with full seat liner design fully molded around the body.
   2. Manufacturer/Model
      a. Asahi/Type 57P.
      b. Engineer Approved Equal.
   3. End Connection:
      a. Wafer, ANSI Class 150.
   4. Pressure Rating:
      a. 150 psig (100 psi for valves larger than 10")
   5. Materials of Construction:
      a. Body, Disc, Seat Bush:
         1) H707 PVC, ASTM D1784 1245A
      b. Seat, O-ring, and Gasket:
         1) EPDM.
      c. Stem:
         1) 316 SST.
      d. Screw and Bolt:
         1) 304 SST.

L. Ball Valve (BA-Thermoplastic)
   1. Description: Thermoplastic construction type, true union ball valve with two-way blocking capability.
   2. Manufacturer/Model
      a. Asahi/Type 21/21A.
      b. No Approved Equals.
   3. End Connection:
      a. True Union.
   4. Pressure Rating:
      a. 230 psig (150 psi for valves larger than 3") up to temperatures of 70 degrees F
   5. Vent Hole:

a. Provide valves equipped with 1/8-inch vent holes for all sodium hypochlorite (NaOCl) applications.

6. Materials of Construction:
   a. Body, Ball, Carrier, End Connector, union Nut, and Stem:
      1) H707 PVC, ASTM D1784 1245A
   b. Seat:
      1) PTFE.
   c. O-rings:
      1) EPDM (water service).
      2) PTFE (chemical service).
   d. Stop Ring:
      1) PVDF.
   e. Handle:
      1) ABS
   f. Ring:
      1) 304 SST

M. Diaphragm Valve (DV-Thermoplastic)
1. Description: Thermoplastic construction type, diaphragm valve.
2. Manufacturer/Model
   a. Asahi Type 14.
3. End Connection:
   a. True Union.
4. Pressure Rating:
   a. 150 psi up to temperatures of 105 degrees F
5. Materials of Construction:
   a. Body, Bonnet, Carrier, and Union Nut:
      1) PVC
   b. Diaphragm and Cushion:
      1) EPDM.
   c. O-rings:
      1) EPDM.
   d. Handwheel:
      1) Polypropylene
   e. Screw:
      1) 304 SST

N. Check Valve (CV-Thermoplastic)
1. Description: Thermoplastic construction type, ball check valve.
2. Manufacturer/Model
   a. Asahi Type 14.
3. End Connection:
   a. True Union.
4. Pressure Rating:
   a. 150 psi up to temperatures of 120 degrees F
5. Materials of Construction:
   a. Ball, Body, End Connector, Union Nut, and Stop Ring:
      1) PVC
   b. Diaphragm and Cushion:
      1) EPDM.
   c. Seat and O-rings:

1) EPDM (water service).
2) PTFE (chemical service).

O. Overflow Check (CV-Overflow)
1. Description: Wafer style, full face check valve.
2. Manufacturer/Model
a. Tideflex Waterflex.
3. End Connection:
a. Flanged.
4. Pressure Rating:
a. 50 psi.
5. Materials of Construction:
a. Disc:
1) 304 SST.
b. Waterflex Membrane:
1) EPDM.

2.4 AIR RELEASE VALVES

A. Combination Air Valve (CAV)
1. Description:
a. AWWA C-512 combination air/vacuum valve.
2. General:
a. The CAV shall be designed to allow large quantities of air to escape out the orifice when filling a pipeline and to close water tight when the liquid enters the valve. The Air/Vacuum Valve shall also permit large quantities of air to enter through the orifice when the pipeline is being drained to break the vacuum. The discharge orifice area shall be equal or greater than the inlet of the valve.
b. The valve shall consist of a body, cover, baffle, float and seat. The baffle will be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely. The seat shall be fastened into the valve cover without distortion and shall be easily removed, if necessary. The float shall be stainless steel, and shall be center guided into the seat.
3. End Connection:
a. NPT Threaded.
4. Materials of Construction:
a. Body and Cover:
1) ASTM A126 Gr.B Cast iron or ASTM A536 Gr 65-45-12 Ductile Iron.
b. Float:
1) 304 SST.
c. Seat:
1) Buna-N.
5. Rated Pressure: 175 psi.
6. Manufacturer/Model:
a. DeZURIK (APCO)/AVV.
b. GA
c. Crispin
d. VAL-MATIC
7. All CAVs shall include a SST ball valve for isolation. Contractor shall field route drain piping for CAV to the nearest floor or trench drain. Piping from host pipe to CAV shall be SST, pipe from ARV to drain shall be SCH 80 PVC.

B. Air Release Valve (ARV)
   1. Description:
      a. AWWA C-512 combination air valve.
   2. General:
      a. Float operated and shall incorporate a simple lever mechanism to enable the valve to automatically release accumulated air from a fluid system while that system is pressurized and operating.
   3. End Connection:
      a. NPT Threaded.
   4. Materials of Construction:
      a. Body and Cover:
         1) ASTM A126 Gr.B Cast iron or ASTM A536 Gr 65-45-12 Ductile Iron.
      b. Float, seat, needle, linkage, all other internals, and hardware:
         1) 304 SST.
   5. Rated Pressure: 175 psi.
   6. Manufacturers:
      a. DeZURIK (APCO)/ARV.
      b. GA
      c. Crispin
      d. VAL-MATIC
   7. All ARVs shall include a SST ball valve for isolation. Contractor shall field route drain piping for ARV to the nearest floor or trench drain. Piping from host pipe to ARV shall be SST, pipe from ARV to drain shall be SCH 80 PVC.

2.5 ACTUATORS - MANUAL

A. Type: Hand-wheel, lever, chain-wheel, chainlever or operating nut.

B. Location
   1. Hand-wheel or Lever: Comply with Schedules
   2. Chain-wheel or Chainlever: All valves with centerline more than 6'-0" above the operating floor level.
   3. Operating Nut: 2 inch square, all buried valves unless otherwise specified in Schedules

C. Gearing
   1. Refer to individual valve specification.
   2. Location: All valves requiring operating torque in excess of that provided by maximum pull of 80 lb on hand-wheel or chain-wheel or maximum input of 150 ft lb on operating nuts.
   3. Design: Totally enclosed.

D. Chain-Wheel Operator Details
   1. Chain-Wheel: Manufacturer's standard design or sprocket wheel bolted directly to valve hand-wheel.
   2. Chain Length and Size: Provide aluminum alloy chain for all chain-wheel-operated valves. Length of chain shall be such that chain comes within 3'-6" of the floor.
   3. Chain-Hold Device: Equip each operator with 1/2-inch hook bolt located to hold chain from walking area.

E. Additional Butterfly Valve Operator Details
   1. Stop-limiting Devices: Provide for open and closed position.

2. Design: Adequate to avoid damage to all components from 200 lb pull on hand-wheel or chain-wheel operators, or 300 ft lb input torque on operating nuts.
3. Comply with all applicable AWWA standards.

2.6 ELECTRIC ACTUATORS - MODULATING

A. All electric actuators shall conform to the requirements of AWWA C-542.

B. All actuators shall be multi-turn type with gearbox, suitable for modulating service.

C. Refer to the valve schedule for service conditions.

D. Actuators shall contain motor, gearing, manual over-ride, limit switches, torque switches, drive coupling, integral motor controls, position feedback transmitter, and digital position indicator.

E. Motor
1. Designed for actuator service.
2. Induction type.
3. Insulation: Class H.
4. Protected by thermal switches imbedded in the motor windings.
5. Totally enclosed, non-ventilated.
6. Voltage: As indicated on the electrical drawings.

F. Actuator and Gearbox Enclosure:
1. Valves inside tanks, vaults, trenches, or other submersible locations: IPS 68.
2. All other locations: NEMA 4X.

G. External Fasteners
1. Stainless steel.
2. Fasteners on terminal compartments shall be captured to prevent loss while cover is removed.

H. Gearing
1. Oil-lubricated.
2. Designed to withstand full stall torque of the motor.

I. Manual Operation
1. Manual over-ride shall be by handwheel.
2. Manual operation shall be via power gearing.
3. Return from manual to electric mode of operation shall be automatic upon motor operation.
4. A seized or inoperable motor or power gearing shall not prevent manual operation.
5. Manual operation shall be possible with electric components removed.

J. Limit Switches
1. Limit switches shall be furnished at each end of travel.
2. Switch adjustment shall not be altered by manual operation.
3. Switches shall be capable of quick adjustment without removing covers.
4. Furnish two sets of normally open and two sets of normally closed contacts at each end of travel. Contacts shall be capable of reliably switching low voltage DC source from the control system.

K. Torque Switch
   1. Furnish torque switch at each end of travel.
   2. Switch shall trip when the valve load exceeds the switch setting.
   3. Switch adjustment device shall be calibrated directly in percent of torque.

L. Wiring: Wiring shall be terminated at a separately sealed terminal compartment.

M. Temperature Range: Actuator shall be capable of operating in an ambient temperature range of –20 to +160 deg F (with motor controls).

N. The required dynamic valve torque shall be no more than 60% of the electric actuator's maximum rated breakaway torque. Power gearing shall have zero backlash between the motor and actuator output.

O. All actuators shall be provided with the following:
   1. Feedback potentiometer.
   2. Reversing starter.
   3. Control transformer.
   4. Phase rotation correction.
   5. Monitor relay.
   6. Positioner capable of accepting a 4-20 mADC command signal and positioning the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field adjustable to fail to the open, closed, or last position on loss of signal.
   7. "Open – Close" pushbuttons.
   8. "Local – Off – Remote" selector switch.
   9. Red and green indicating lights or LED's.

P. Manufacturer: AUMA.

2.7 ELECTRIC ACTUATORS – FOR ON/OFF SERVICE

A. All electric actuators shall conform to the requirements of AWWA C-542.

B. All actuators shall be multi-turn type with gearbox, suitable for modulating service.

C. Refer to the valve schedule for service conditions.

D. Actuators shall contain motor, gearing, manual over-ride, limit switches, torque switches, drive coupling, integral motor controls, and digital position indicator.

E. Motor
   1. Designed for actuator service.
   2. Induction type.
   3. Insulation: class H.
   4. Protected by thermal switches imbedded in the motor windings.
   5. Totally enclosed, non-ventilated.
   6. Voltage: As indicated on the electrical drawings.

F. Actuator and Gearbox Enclosure:
   1. Valves inside tanks, vaults, trenches, or other submersible locations: IPS 68.

2. All other locations: NEMA 4X.

G. External Fasteners
1. Stainless steel.
2. Fasteners on terminal compartments shall be captured to prevent loss while cover is removed.

H. Gearing
1. Oil-lubricated.
2. Designed to withstand full stall torque of the motor.

I. Manual Operation
1. Manual over-ride shall be by handwheel.
2. Manual operation shall be via power gearing.
3. Return from manual to electric mode of operation shall be automatic upon motor operation.
4. A seized or inoperable motor or power gearing shall not prevent manual operation.
5. Manual operation shall be possible with electric components removed.

J. Limit Switches
1. Limit switches shall be furnished at each end of travel.
2. Switch adjustment shall not be altered by manual operation.
3. Switches shall be capable of quick adjustment without removing covers.
4. Furnish two sets of normally open and two sets of normally closed contacts at each end of travel. Contacts shall be capable of reliably switching low voltage DC source from the control system.

K. Torque Switch
1. Furnish torque switch at each end of travel.
2. Switch shall trip when the valve load exceeds the switch setting.
3. Switch adjustment device shall be calibrated directly in percent of torque.

L. Wiring: Wiring shall be terminated at a separately sealed terminal compartment.

M. Temperature Range: Actuator shall be capable of operating in an ambient temperature range of –20 to +160 deg F (with motor controls).

N. The required dynamic valve torque shall be no more than 60% of the electric actuator's maximum rated breakaway torque. Power gearing shall have zero backlash between the motor and actuator output.

O. All actuators shall be provided with the following:
1. Reversing starter.
2. Control transformer.
3. Phase rotation correction.
4. Monitor relay.
5. "Open – Close" pushbuttons.
6. "Local – Off – Remote" selector switch.
7. Red and green indicating lights or LED's.

P. Manufacturer: AUMA.

2.8 PNEUMATIC ACTUATORS

A. General
1. Pneumatically operated spring return actuators of the rack and pinion design, totally enclosed in a single enclosure with no external moving parts.
2. Actuators shall travel a minimum of 95 degrees in each direction to allow for over travel adjustment.
3. Output torque shall be linear throughout travel.
4. Factory lubricated with no field lubrication required.
5. Capable of mounting in any position without loss of performance.
6. Suitable for both on/off and throttling applications.
7. Heavy duty mechanical limit switches with solid state analog position feedback.
8. Visual position indicator.
9. Dual travel stops.
10. Manual over-ride on solenoids.
11. Adjustable open/close speed control.
12. Output torque: 44,130 lb-in minimum.

B. Materials of Construction:
1. Body and Endcaps:
   a. Extruded, anodized aluminum alloy.
2. Pistons:
   a. Die cast aluminum alloy.
3. Output Shaft/Pinion:
   a. 304 SST.
4. Travel stops:
   a. Alloy steel.
5. Shaft bearings and piston guides:
   a. Acetal.
6. Fasteners:
   a. 304 SST.
7. Spring:
   a. Spring steel with protective coating.
8. O-ring seals:
   a. Buna-N.
9. Temperature Rating:
   a. -4 to 200 degrees F.
10. Pressure Rating:
   a. Up to 140 psig.

C. Manufacturer: Bray Series 93 or Engineer Approved Equal.

2.9 ACCESSORIES

A. Flow Straighteners (Inlet Flow Conditioners)
1. Provide where indicated on process drawings.
2. Provide a certified drawing including dimensions, weight, welding requirements, material designations, material thicknesses and flange details for review with pump submittal.
3. Provide flow conditioning grid design approved by a nationally recognized physical hydraulic modeling laboratory.

a. For pipe sizes larger than 18-inch provide a design based on physical hydraulic modeling by a nationally recognized physical hydraulic modeling laboratory

4. Design Criteria:
   a. Spool, Minimum Length: 1 x Pipe diameter
      1) Ends: Flanged: ANSI 150-lb standard
      2) Type: Van Stone flat face rings and back-up flanges
   b. Grid, Minimum Length: 1 x Pipe diameter
      1) Thickness: 0.125 inch (3 mm)
      2) Grid Spacing: 4 inch (100 mm) nominal
      3) Velocity: Maximum 7 ft/s (2.13 m/s).
5. Materials:
   a. Spool: Type 316L A778 welded stainless steel pipe, Schedule 10S
   b. Van Stone flat face rings and back up flanges: Type 316Lstainless steel
   c. Hardware: Type 316 stainless steel
6. Finish:
   a. Pickled and passivated
   b. Completely immerse for a minimum of 15 minutes in 10 percent nitric acid and 3 percent hydrofluoric acid at 125 degrees Fahrenheit, followed by a neutralizing rinse.
7. Manufacturers:
   a. Flow Optimizers, LLC.
   b. Or Engineer approved equal.

B. Fire Hydrants
1. Cast Iron, conform to AWWA C-502, dry-barrel type.
2. Bell Connection Size: 6-inch.
3. Pumper Connection: One 4-1/2-inch diameter NST connection.
4. Main Valve Opening: 5-inch diameter Storz fitting and cap.
5. Hydrants shall have a 5-1/4-inch bronze to bronze seat.
6. Depth of Bury:
   a. Watermain 12-inches and less in diameter: 5’-0”
   b. Watermains greater than 12-inches in diameter: 5’-6”
7. Threads on nozzles shall match those standard for local fire department.
8. All valve shall open left.
9. Manufacturers:
   a. Mueller A-423 Super Centurion
   b. Kennedy 81A
   c. Darling B62B
   d. Clow Medallion

C. Pressure Gauges and Compound Gauges
1. Dial Size:
   a. 4-inch minimum.
2. Accuracy:
   a. Not less than 1/2 of 1% of scale range.
3. Connection:
   a. 1/2-inch NPT male connection
4. Dampening:
   a. Provide dampener (Ashcroft No. 1106 or equal) for each high service discharge gage.
5. Manufacturers:

a. Ashcroft/Duragauge.
b. AMETEK/Solfront 1929.
c. McDaniels/MPB/SC.

6. Materials of Construction:
   a. Case:
      1) Phenolic, PET turret, or fiber reinforced thermoplastic.
   b. Internals and wetted parts:
      1) 316 SST.
   c. Dampening fluid:
      1) Glycerin.
7. Mounting and installation:
   a. Provide SST piping and isolation valve. Refer to detail on Drawings.
8. Gage Schedule:
   a. As shown on Drawings.

D. Y-strainer
1. Description: Sediment strainer to protect pipeline comments by removing suspended solids and impurities.
2. Manufacturer/Model
   a. Asahi/sediment strainer.
   b. Engineer approved equal.
3. End Connection:
   a. True Union.
4. Pressure Rating:
   a. 150 psig (85 psi for valves larger than 3”).
5. Screen Size:
   a. 20 mesh.
6. Materials of Construction:
   a. Body, screen support, end connection, union nut, retaining ring, and split ring:
      1) PVC with transparent body
   b. Filter screen:
      1) PVC.
   c. O-rings:
      1) EPDM (water service).
      2) PTFE (chemical service).
   d. Stop Ring:
      1) PVDF.

E. Quick Connect Coupling
1. Material: Polypropylene.
2. Ends: 150 lb. Flat face flange x female.
3. Provide polypropylene lockable cap.
4. Manufacturer: Banjo Corporation.

F. Valve Appurtenances
1. Valve Extension Stems, Stem Guides, Wrenches and Keys
   a. Extension Stem: Size at least as large as stem of operated valve.
   b. Intermediate Stem Guide(s): Install for extensions more than 8 feet long or as shown on the Drawings.
   c. Stem brackets and guides
      1) Cast iron having fully adjustable bronze bushed guide block.

2) Mounting: Comply with Division 40, Section “Pipe Supports”.
3) Stem brackets and guides located within the pre-treatment basins shall be 304 stainless steel as indicated on the drawings.

d. Operating nuts
1) Provide 2-inch square nut with each extension stem.
2) Locate in floor box or grating recess as required.

e. Number: Provide operating key or wrench of suitable length and size for each valve that is not readily accessible to direct operation.

G. Valve Floor Boxes
1. Location: Provide at all valves operated from floor above.
2. Construction
a. Material: Cast iron.
b. Depth: Metal floor slab thickness.
c. Cover: Cast iron with bronze bushing.

H. Expansion Joints
1. Expansion joint shall allow axial compression or expansion, lateral movement, and axial deflection.
2. Expansion joints shall be installed at the following locations:
a. Straight piping runs over 50 ft. and at least every 50 ft. for all interior PVC and CPVC chemical piping systems.
b. All locations as shown on the drawings.
3. Materials of Construction:
a. All Materials shall be NSF approved.
b. Elastomer:
1) EPDM.
c. Retaining rings:
1) 304 SST.
d. Control units, nuts, and washers:
1) 304 SST.
4. Install expansion joints in tension to facilitate removal.
5. Manufacturer/Model:
a. Proco/Style 231.
b. Engineer Approved Equal.

PART 3 - EXECUTION

3.1 VALVES, GATES AND ACCESSORIES: INSTALLATION

A. General
1. Install in accordance with Manufacturer's recommendations.
2. Install valves for convenient operation of hand-wheels or wrenches from the operating floor without interfering with access as acceptable to the Engineer or Owner.
3. Orientation of Valves
a. Install valves plumb and level unless otherwise approved.
b. Install valves free from distortion and strain caused by misaligned piping, equipment or other causes.

B. Fire Hydrants and Extensions
1. Fire Hydrants

a. Locate approximately as shown on the Drawings with final location and setting determined in field by Engineer.
b. Individually valve all new fire hydrant leads.
c. Use mechanical joint anchoring fittings as shown.
d. Install hydrants with suitable concrete backing and gravel fill for drainage as shown on Drawings.
e. Do not obstruct drain openings.

2. Hydrant Extensions
a. Provide complete, including barrel and stem sections, where shown on Drawings or directed by Engineer.
b. The Engineer or Owner reserves right to order extensions installed before or after hydrant setting.

C. Tapping Sleeves and Valves
1. Install where shown on the Drawings.
2. Install under pressure in strict accordance with Manufacturer's recommendations.
3. Satisfactorily test under 150 psi pressure prior to cutting operations. If leaks appear, make repairs and re-test.

D. Corporation Stops: Install at all points shown and where required to avoid air binding of piping systems.

E. Valve Appurtenances
1. Valve Boxes
a. Install plumb with the bodies centered directly over the valves.
b. Carefully tamp earth fill around each box to a distance of 4 feet on all sides.
c. Tamp earth fill to the undisturbed trench face, if less than 4 feet.

3.2 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping
1. Locations of existing piping shown shall be considered approximate.
2. Contractor is responsible for determining exact location of existing piping to which he must make connections, may disturb during earth moving operations, or may affect in any way by his work.

B. Removing Existing Pipelines from Service
1. Pipelines shall not be removed from service unless approved by the Engineer or Owner.
2. Notify the Engineer and Owner at least 48 hrs prior to taking pipeline out of service.

C. Work on Existing Pipelines
1. Cut piping as shown or required using machines designed specifically for this work.
2. Install temporary plugs to keep out all mud, dirt, water and debris.

END OF SECTION 40 0523

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SECTION 40 9000

PLANT INSTRUMENTATION AND CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, and place in satisfactory operation, instrumentation and control system equipment necessary to perform specified functions in accordance with the requirements of Sections 40 9XXX and the Drawings. The system includes, but is not necessarily limited to, the following equipment:

1. Primary sensor/transducers, field instruments, and associated mounting hardware as specified in Section 40 9100, Primary Sensors and Field Instruments.
2. Local control panels, monitoring panels, and existing panel modifications as shown on the Drawings.
3. An expansion of the existing plant-wide control system including processors, communication modules, input/output modules, operator interface stations, as specified and as shown on the Drawings.
4. Interconnecting cables, wiring, and associated components. Ethernet networking components such as switches, transceivers, fiber optic and twisted-pair patch panels and patch cables, and equipment enclosures as specified and shown in the Contract Documents and in Section 40 9553, Network Devices.

B. Configuration and programming of control system end devices such as but not limited to: instruments, device serial networks, actuator master stations, variable frequency drives, motor protection units, actuators, etc., shall be provided by the Contractor. Unit process logic residing in the process area PLC(s), OIT system and/or HMI system depicting the process monitoring and controls shall be provided by the Contractor.

C. This Section and the other Division 40 Sections illustrate and describe the overall instrumentation and control system functional and operational requirements.

D. Contractor shall conform to the requirements specified within Division 40 9000 for the selection of equipment and materials, installation methods, configuration and programming. In addition, it should be noted that Division 40 9000, Plant Instrumentation and Control System General Requirements, are not limited to work in this Division, but are also imposed for equipment and systems specified in other Divisions of the Contract Documents.

E. Related Sections:

1. Section 40 9100, Primary Sensors and Field Instruments
2. Section 40 9443, Plant Control System
3. Section 40 9513, Control Panels
4. Section 40 9553, Network Devices

1.2 REFERENCES

A. Reference Standards: The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in this Specification and the Drawings.
   1. American National Standards Institute (ANSI)
   2. ANSI C1, "National Electrical Code" (NEC)
   3. Factory Mutual (FM)
   4. Institute of Electrical and Electronic Engineers (IEEE)
   5. Instrumentation, Systems, and Automation Society (ISA)
   6. Society of Automotive Engineers (SAE)
   7. National Electrical Manufacturers Association (NEMA)
   8. National Fire Protection Association (NFPA)
   9. National Institute of Standards and Technology (NIST)
   10. Scientific Apparatus Makers Association (SAMA)
   11. Underwriters Laboratories (UL)
   12. Occupational Safety and Health Administration (OSHA)

1.3 DEFINITIONS

A. Control System: The Control System shall be comprised of all the instrumentation and control system equipment throughout the Contract Documents, including but not limited to:
   1. Instrument loop components including, but not limited to: primary elements, sensors, transducers, transmitters, indicators, controllers, and recorders.
   2. Final operators or control elements including, but not limited to: control valves, solenoids, motors, adjustable frequency drives, and louver operators.
   3. Indicating and control devices including, but not limited to: operator interface terminals, pushbuttons, selector switches, pilot lights, recorders, and indicators.
   4. Ancillary components including, but not limited to: instrument power supplies, signal repeaters, signal isolators, current trips, adder/subtractor modules, relays, and timers.
   5. Instrumentation power requirements including, but not limited to: dedicated power, power conditioning, uninterruptable power supplies, and grounding systems.
   6. Cabinets, consoles, panels, and enclosures
   7. Alarm systems
   8. Boiler controls and control systems
   9. Controls for process equipment and systems including, but not limited to: service pumps, chemical systems, filtration, sample pumps, sump pumps, and treatment systems
   10. Motor controls
   11. Programmable controllers (PLCs)
   12. Distributed control systems (DCSs)
   13. Supervisory control and data acquisition systems (SCADA)
   14. Wiring and conduit
   15. Network Communication system equipment and wiring

B. Instrumentation and Control System Integrator: The instrumentation and control system integrator shall furnish a complete and integrated instrument and control system including, but not limited to: detailed design, engineering, fabrication, assembly, testing, checkout, commissioning, debugging, and training in accordance with the Contract Documents.

1.4 SYSTEM DESCRIPTION

A. General Design Requirements:

1. Power Supplies:
    a. All electrically powered equipment and devices shall be suitable for operation on 115 V +/- 10%, 60 Hz +/- 2 Hz power. If a different voltage or better regulation is required, a suitable regulator or transformer shall be provided.
    b. Appropriate 24 VDC power supplies for analog loop power shall be furnished for each two wire transmitter. Power supplies shall be mounted in control panels or enclosures.
    c. Provide power supplies sized for a minimum of 130% of the maximum simultaneous current draw of all connected load.
    d. A power on off switch or a molded case circuit breaker shall be furnished for each item requiring 120 VAC electrical power.
    e. Provide isolation transformers, transient voltage surge suppressers, line voltage regulators, and output line reactors for power distribution as required to eliminate electrical noise and/or transients entering on power lines.
2. Signal Requirements:
    a. The control system shall be designed to use 4 to 20 mA DC analog signals and/or digital communication networks as specified in Sections 40 9XXX, or as shown on Contract Drawings.
    b. Signal converters and repeaters shall be provided where required for proper interfacing. Power supplies shall be sized adequately for signal converter and repeater loads.
    c. Signals shall be isolated from ground. Shields of 4 to 20 mA and thermocouple 2-wire systems shall be grounded at a single point only. Ground 4 to 20 mA shields only at the control panel that contains the associated 2-wire loop power supply, unless shown otherwise. Ground thermocouple sensors at the thermocouple.
    d. This system will be used in a water treatment plant environment where there can be high energy AC fields, DC control pulses, and varying ground potentials between the sensors/transducers and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.
3. Miscellaneous:
    a. All new equipment provided shall be listed by Underwriters Laboratory or other testing agency as defined in these Specifications. Such listing requirements only apply for equipment where such listings exist.
    b. All instrumentation and control system components shall be heavy duty types, suitable for continuous service in a municipal water treatment plant environment.
    c. All similar components shall be products of a single manufacturer and shall consist of equipment which are currently in production and shall remain in production for at least 2 years.
    d. All instrumentation and control system components shall be designed to automatically return to accurate measurement within 60 seconds upon restoration of power after a power failure or when transferred to standby power supply.
    e. Surge and lightning protection shall be provided for all power supplies, field instruments, and all other control system components to protect against damage by electrical surges.
    f. All field mounted instruments and system components shall be designed for installation in high humidity and corrosive service conditions. All field mounted instrument enclosures, junction boxes, and appurtenances shall have a NEMA 4X endorsement, at a minimum. Hazardous areas require a NEMA 7 endorsement.

g. All components with interconnections to field devices shall be wired through terminal blocks. Integral terminals, such as that of a relay, are not an acceptable alternate.
h. All components furnished including field and rear of panel instruments shall be tagged with the item number and nomenclature indicated on the Contract Documents and/or approved Shop Drawings.
i. Ranges and scales specified herein shall be coordinated to suit field conditions and equipment furnished.
j. Field mounted devices, instruments and control panels/enclosures located outdoors shall be protected from exposure to freezing temperatures and from overheating due to prolonged exposure to high ambient temperatures and shall be provided with sunshields where necessary to protect the enclosure surfaces from the additional heating effects of exposure to direct sunlight.
k. Field instruments mounted in hazardous areas shall be provided as "factory sealed" units whenever available which can be installed in non-explosion proof enclosures in Division 2 areas and in explosion proof enclosures in Division 1 areas, in both cases without the need for conduit seals.

4. System Designs:
a. Range, scale, and setpoint values specified are for initial setting and configuration. Modifications to these values may be required based on actual equipment furnished and as necessary to implement proper and stable process actions which are determined as systems are placed in operation. These modifications shall be done by Contractor at no additional cost to the Owner.
b. For any items where ranges, scales, and setpoints may not have been specified, Contractor shall submit a recommendation to the Owner for review.

1.5 SUBMITTALS

A. Product Data: Control System Components Submittal Requirements:
1. Sensors/transducers and field instruments: Product data and Manufacturer's literature include the following:
a. Instrument Specification Form: SP20 Instrumentation Specification Forms were developed by the ISA Standards Committee for most commonly used instruments. Submit a completed SP20 instrument specification form for each instrument.
b. Manufacturer's product name and model number and all required accessories
c. Instrument tag number from Contract Documents
d. Manufacturer's standard catalog product data with irrelevant sections crossed out.
e. Description of construction features
f. Performance and operation data
g. Installation and mounting details, instructions, and recommendations
h. Identification of all wiring interconnections and points of connection
i. Service requirements
j. Dimensions
2. Programmable Controller (PLC) System Information:
a. System Description:
1) Detailed block diagram showing system hardware configuration and identifying manufacturers and model numbers of system components.
2) Format, protocol, and procedures for remote communications and local communications with input/output modules and peripheral devices
3) On-line and off-line capabilities for programming, system utilities and diagnostics

4) Input/output point listing with I/O module cross reference identification
5) List of repair parts and test equipment

b. Equipment Hardware:
1) Manufacturer's standard catalog product data for all system components
2) Layout drawings showing front, rear, end, and plan views to scale of all processing equipment, I/O components, power supplies, and peripheral devices.
3) Construction details, features, and procedures
4) Interconnection diagrams including termination details, cable identification lists, and cable lengths
5) Plans showing equipment layout in control panels
6) Installation requirements, instructions, and/or recommendations

c. Software Description:
1) Standard technical documentation covering all aspects of the programmable controller software functions and capabilities, including functional descriptions and programming procedures related to control, monitoring, logging, and alarming functions.
2) Documentation describing memory type, size and structure, and listing I/O and Data Table memory and size of memory available for programs.

3. Control Panel and Enclosure Information:
a. Layout Drawings shall include the following:
1) Front and plan views to scale
2) Dimensional information
3) Tag number and functional name of components mounted in and on panel or enclosure
4) Product information on all panel components:
a) Manufacturer's product name and model number
b) Instrument tag number from Contract Documents
c) Manufacturer's standard catalog product data with irrelevant information crossed out
d) Description of construction features
e) Performance and operation data
f) Installation and mounting details, instructions, and recommendations
g) Identification of all wiring interconnections and points of connection
h) Service requirements
i) Dimensions
5) Nameplate location and legend including text, letter size, and colors to be used
6) Location of anchoring connections and holes
7) Location of external wiring and/or piping connections
8) Mounting and installation details

b. Panel schematic and internal point-to-point wiring and/or piping diagrams shall include the following:
1) Name of panel or enclosure
2) Wiring sizes, types, and numbers
3) Piping sizes, types, and numbers
4) Terminal strip and block numbers for all interconnections.
5) Color coding
6) Functional name and manufacturer's designation for components to which wiring and piping are connected

c. Electrical control schematics in accordance with SAE HS-1738 standards for all circuits indicated in the specifications or on the Contract Drawings. Generic or typical wiring diagrams, not specific to equipment being provided, will not be accepted. Tables or charts to describe wire numbers will not be accepted. All wires shall be labeled and shown on the submittal drawings as shown on the sample drawings at the end of this Section.
d. Plan showing control panel and enclosure equipment layout in each area.
e. Stock lists or Bill of Materials for each panel including tag number, functional name, manufacturer's name, manufacturer's model number, and quantity for all components mounted in or on the panel or enclosure. Bill of Materials shall include the information shown on the sample drawings at the end of this Section.
f. Heat calculations for each panel or enclosure to verify that there is sufficient dissipation and/or generation of heat to maintain interior panel temperatures within the maximum and minimum operating temperature of all panel components with ambient temperatures as specified below.
g. Samples:
    1) One (1) sample nameplate for exterior panel mounting
    2) One (1) sample nameplate for interior panel device mounting
    3) One (1) sample terminal block
    4) Three (3) sample wire labels

4. Field Wiring (Riser) Diagrams:
    a. Shall include the following:
        1) Wiring and conduit sizes, types, and numbers
        2) Terminal strip numbers for each wire termination
        3) Color coding
        4) Location, functional name, and manufacturer's designation of items to which wiring and/or piping are connected
        5) Point to point wiring diagrams shall include all interconnections between field devices, panels, control stations, lighting panels, and motor starters.
5. PLC I/O Loop Wiring Diagrams:
    a. Prepare drawings on a module-by-module basis and include the following information:
        1) Rack numbers, module type and slot number, and module terminal point numbers. Also include location and identification of all intermediate panel and/or field terminal block and strip numbers to which I/O wiring and power supply wiring is connected. Identify all power supply circuit numbers and ratings.
        2) Wiring sizes, type, wire numbers and color coding
        3) Designation of conduits in which field I/O wiring is routed
        4) Location, functional name, tag numbers and manufacturer model numbers of panel and field devices and instruments to which I/O wiring is connected. For discrete I/O devices use P&ID electrical symbols tagged with designation shown on SAE HS-1738 drawings.

B. Operation and Maintenance (O&M) Manuals:
1. Operating and Maintenance Instructions, the Instrumentation and Control System O&M Manuals shall include:
    a. Name, address, and telephone number of each manufacturer's local service representative. Also include internet web site URL and email address when available.

b. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.
c. Copy of all approved submittal information and system shop drawings as specified herein with corrections made to reflect all shop drawing review comments and the actual system as tested and delivered to the site for installation.
d. Manufacturer's Original Copies of Hardware, Installation, Assembly, Programming, and Operations Manuals for all control system components. Manuals shall include the following information:
    1) General descriptive information covering the basic features of the equipment
    2) Physical description covering layout and installation requirements and all environmental constraints
    3) Standard technical documentation covering the procedures for programming, operation, start-up, shutdown, and calibration of the equipment and explaining how the various control functions are performed.
    4) Principles of operation explaining the logic of operation; provide information covering operation to a component level.
    5) Maintenance procedures covering checkout, troubleshooting, and servicing; checkout procedures shall provide the means to verify the satisfactory operation of equipment, trouble-shooting procedures shall serve as a guide in determining faulty components, and servicing procedures shall cover requirements and recommended time schedule for calibration, cleaning, lubrication and other housekeeping and preventive maintenance procedures.
    6) Wiring, schematic, and logic diagrams
    7) Safety considerations relating to operation and maintenance procedures
    8) Manufacturer's recommended spare parts list with model numbers

2. After the initial Operating and Maintenance Instructions have received an acceptable disposition, the manual has been field verified and all final corrections have been made by the Contractor, submit 2 electronic versions of the approved manuals on CD to the Owner.
    a. The electronic color copy shall be an original, computer generated multi-page Portable Document Format (PDF) file. Scans or pictures of document text will not be accepted.
        1) Provide a hyperlinked and bookmarked colored index page hyperlinked and bookmarked to appropriate pages. There shall be a universal return to the index on all pages linking back to the index page.
        2) All oversized pages shall be properly sized (to original dimensions) and orientated correctly.
        3) Each PDF file shall be no larger than 100 Mb. Any additional files shall be suffixed with an underscore and a number indicating its position.
    b. Data files, such as those for drawings, source code, ladder logic, etc. shall be submitted in its native electronic format, in addition to PDF form for printing.
    c. If self-adhesive labels are provided, it must fully cover the CD and be exactly centered on the CD. The front surface of the CD shall contain the following type written information:
        1) Contract number
        2) Specification Section number
        3) Submittal number
        4) Brief submittal description
        5) Submittal date

C. Supplier's Qualifications:

1. Shall submit experience of successful instrumentation and control system equipment installations as specified in paragraph 1.6 of this Section.

D. Installation/Inspection Data:
   1. Prior to commissioning, furnish to Owner an installation inspection report certifying that all equipment has been installed correctly and is operating properly.
   2. The report shall describe the inspection and test procedure and include any repairs, modifications, or other work performed during the factory test or on-site.
   3. The report shall be signed by the Contractor and the system integrator's authorized representative.

E. Product/Material Certifications
   1. Submit to the Owner certified calibration certificates for field instruments and devices specified in Section 40 9XXX, a minimum of 3 weeks prior to commissioning.
      a. Receipt of any calibration certificate shall in no way imply acceptance of any work or instrument.
      b. The calibration certificates shall contain the information shown on the sample calibration certificate included at the end of this Section.
      c. Each calibration certificate shall be signed and dated by the authorized manufacturer's representative and Contractor.

F. Record Drawings and Documentation:
   1. All revised shop drawings and documentation shall be submitted to the Engineer to replace out dated drawings and documentation contained in the System O&M Manuals. Specific instructions for out dated drawing removal and replacement shall be provided with the record drawing submittal.
   2. Record Drawings shall include all data required to identify, locate, and trace circuits.
      a. Required data shall include, but not be limited to, equipment names, conduit numbers, boxes, conductor labels and colors, and terminals.
      b. Control Panel Layout Drawings shall include, but not be limited to, the following information:
         1) Bill of materials identifying all components
         2) Enclosure layouts (interior and exterior) including face, sides, back, and subpanels identifying all components
         3) Nameplate legend for all components
      c. Interconnect Wiring Diagrams shall include, but not be limited to, the following information:
         1) Identify all wiring components between each end device and PLC terminal(s).
         2) Conductor labels shall be consistent throughout loops.
      d. Control Diagrams shall include, but not be limited to, the following information:
         1) Index of equally spaced reference numbers along left side of Control Diagram
         2) Include terminal numbers/colors for each control component.
      e. Provide separate connection drawings for components requiring greater number of interconnects to maintain clarity of information.
         1) Information shall include terminal numbers, conductor labels, point, polarity, and function.
      f. Terminal strip drawings shall include terminal strip name, number, point, and conductor label on each side of terminal.

g. PLC rack layout drawings shall include physical module/slot configuration along with point number and description.

3. All Electrical and Instrumentation Record Drawings shall be submitted in hard copy format.

G. Commissioning Procedures and Documentation:

1. Provide the following approved and updated documentation for use before system commissioning.
   a. Complete panel schematic and detailed internal point-to-point wiring interconnect drawings
   b. Complete electrical control schematics
   c. Complete panel layout drawings
   d. Complete field wiring diagrams
   e. The drawings corrected and modified by the Contractor during commissioning shall form the basis for the "As-Built" record drawing requirement as specified in this Section.

H. Storage Requirements:

1. System Integrator shall submit to Owner the storage requirements and recommendations for the equipment prior to shipment.

1.6 QUALITY ASSURANCE

A. General:

1. The instrumentation and control system shall be furnished by a single supplier who shall assume responsibility for providing a complete and integrated system.
2. All equipment, components, and materials required shall be furnished by the single supplier who shall assume the responsibility for adequacy and performance of all items.
3. The supplier shall identify those system components which are not of his manufacture.
4. The supplier shall supply his company's quality assurance plan, and for components which are not of his manufacture, the component manufacturer's quality assurance plan. The plans shall include but not necessarily be limited to: method of testing, raw material criteria, methods of documentation, station control, "Burn In", final tests, serialization coding, and packaging.

B. Instrumentation and Control System Integrator's Qualifications:

1. Shall be a financially sound firm having at least 5 years continuous experience in designing, implementing, supplying and supporting instrumentation and control systems which are comparable to the instrumentation system in terms of hardware, software, cost, and complexity.
2. Shall have in existence at the time of bid advertisement, an experienced engineering and technical staff capable of designing, implementing, supplying, and supporting the instrumentation system and handling the submittal, testing, and training requirements.
3. Shall have an emergency response time ability of less than 4 hours to the project site.
4. Shall have a thorough working knowledge of water/wastewater treatment processes and control philosophy in accordance with standard practices of the water/wastewater treatment industry.
5. System Integrator shall be one of the following:
   a. Dublin Technical Systems, Inc. of Dublin, Ohio
   b. Dmytryka Jacobs Engineers, Inc. of Toledo, Ohio
   c. Quality Controls, Inc of Cincinnati, Ohio

C. Instrumentation and Control System Integrator's Responsibility:
   1. Contractor shall retain the system integrator to assume the responsibilities specified below. However, execution of these specified duties by the system integrator shall not relieve Contractor of the ultimate responsibility for the control equipment.
      a. Detailed design, engineering, fabrication, assembly, wiring, testing, and debugging of the instrumentation and control system in accordance with the Contract Documents, the reviewed submittal drawings, and all referenced standards and codes.
      b. Preparation, assembly, submission, and correction of all instrumentation and control system submittals in accordance with the Contract Documents.
      c. Proper integration and interfacing of the instrumentation and control system hardware, field devices, and panels including required interfacing with package control systems furnished by other equipment suppliers, with existing equipment, and with the plant electrical system.
      d. Supervision of the installation of the instrumentation and control system, instruments, panels, cabinets, wiring, and other components require.
      e. Calibration, testing, and startup of the instrumentation and control system.
      f. Training of Owner personnel in operation and maintenance of the instrumentation and control system.
      g. Handling of all warranty obligations for the control system components.

D. Coordination and Progress Meetings:
   1. Contractor and a representative of the system integrator shall be required to attend meetings applicable to this Section's scope of work.
   2. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit the Contractor and system integrator to agreed procedures and schedules.

E. System Integrator Project Personnel:
   1. Contractor shall require the system integrator to provide the following project personnel:
      a. Project Manager:
         1) The system integrator shall appoint a project manager who shall coordinate and schedule all work and assure that the project schedule is met.
         2) The project manager shall act as the liaison with Contractor for the installation of the instrumentation and control system equipment and shall assist in all matters required for proper coordination and interfacing of the equipment and processes.
      b. Field Engineer:
         1) The system integrator shall appoint a field engineer with responsibilities as follows:
            a) Provide advice and technical consultation relative to installation techniques and procedures for equipment furnished.
            b) Provide guidance and support on-site throughout the control system installation and start-up period.
            c) Installed system checkout, calibration, adjustment, and start up including tuning of every control loop.
            d) Involvement in the onsite system training of plant personnel.
            e) Resolving of control problems encountered during initial startup and testing of all instrumentation and control equipment.

2) The field engineer shall have a minimum of 5 years experience in systems engineering and start up and shall have a thorough working knowledge of the hardware supplied for the instrumentation and control system.

c. The system integrator shall submit resumes for Field Engineer which detail their relevant experience as specified above.

1.7 DELIVERY, STORAGE AND HANDLING

A. Instrumentation and control system equipment shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage.

B. All equipment shall be handled and stored in accordance with manufacturer's instructions and relevant organization standards. Owner shall have the right to inspect stored equipment.

C. Packing and Shipping
1. Package equipment as required to protect it from damage.
2. Mount heavy items on pallets or skids to facilitate handling.

D. Acceptance at Site
1. Inspect all equipment at the time of delivery.
   a. Ensure that no damage has occurred during shipment.
   b. Verify make, model, and quantity.
2. Record the following information:
   a. Description/model of equipment.
   b. Date and time of delivery.
   c. Assessment of condition.
3. Handle equipment carefully to prevent damage.
4. Remove any damaged equipment from site and replace with new equipment.

E. Storage and Protection.
1. Store the equipment provided until it can be installed.
2. Provide a clean, dry, heated, and dust-free location for storage.
3. Such conditions must meet the requirements of the system integrator and manufacturer.

1.8 PROJECT/SITE CONDITIONS

A. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

B. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

C. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

D. Environmental Conditions:
   1. The control system shall be designed and constructed for continuous operation without forming condensation under the following temperature and humidity conditions:
      a. Space Conditioned Areas shown on the Drawings:
         1) Ambient Temperature: normal conditions 59 to 90°F; abnormal conditions 40 to 104°F.
         2) Relative Humidity: normal conditions 20 to 80%
         3) Abnormal conditions up to 95%
      b. Indoor locations for control panels and instruments:
         1) Ambient Temperature: 40 to 120°F
         2) Relative Humidity: 0 to 100%
      c. Outdoor locations for instruments:
         1) Ambient Temperature: -30 to 120°F
         2) Relative Humidity: 0 to 100%

E. Wet and Corrosive Areas:
   1. Instruments and control system components shall be designed and constructed to provide adequate protection against corrosion from gases and chemical which are commonly found in water/wastewater treatment plant environments such as but not limited to zinc orthophosphate, ozone, oxygen, chlorine, and carbon dioxide.

F. Portions of the instrumentation and control system will be located in areas that may be subjected to excessive vibrations. The control system integrator/manufacturer shall specify any vibration limitations which are required for the equipment and provide vibration proof mountings accordingly.

G. Hazardous (Classified) Areas: Hazardous (classified) areas are defined as in accordance with the NEC, NFPA 820, and as shown on the Drawings. All equipment installed in these areas shall conform to requirements for installation in the designated hazardous area as described in Articles 500, 501, and 502 of the NEC.

PART 2 - PRODUCTS

2.1 GENERAL

A. Mounting Hardware: Provide mounting hardware meeting the requirements of Division 26.

B. Identification: Provide equipment identification meeting the requirements of Division 26.

C. Calibrators and Programmers
   1. Provide calibrators/programmers for all I&C equipment that cannot be calibrated from the controls built into the unit.
   2. Provide a minimum of one calibrator/programmer for each type of equipment supplied.

D. Adjustable Dead-Band
   1. Provide dead-band adjustment for all output contacts from all I&C equipment.
   2. Provide a minimum of ±10 percent adjustment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions
   1. Compare the site and existing facilities with the Contract Documents.
   2. With respect to the conditions of the premises, locate connections of existing facilities and any obstructions that may be encountered and conduct work to minimize disruption to existing conditions.

B. Field Measurements: Field-verify all locations and dimensions to ensure that the equipment will be properly located, readily accessible, and installed in accordance with all pertinent codes and regulations, the contract documents, and the referenced standards.

3.2 INSTALLATION - GENERAL

A. General
   1. Equipment locations as shown on the drawings are approximate unless dimensioned.
   2. Coordinate equipment locations with existing conditions and adjust locations as required.
   3. The Contractor shall furnish, fabricate, and mount all instrument stands and brackets. Mounting of stands and instruments shall be per installation detail drawings. All stands must be level, plumb, rigid, and free from vibration. Additional support shall be added where required for vibration-free mounting.
   4. Once instrumentation and control equipment has been set in place, Contractor shall maintain Space Conditioned Areas dust-free and with the following environmental conditions:
      a. Ambient Temperature: 65 to 80°F
      b. Relative Humidity: 50 to 70%
      c. Chlorine: ISA S71.04, Class G2 or better
   5. Provide temporary heating, cooling, dehumidification, humidification and air purification as necessary to provide the above conditions

B. Instrumentation wiring is shown schematically on the plan or described by narrative in the specifications. Contractor to provide type and quantity of wiring necessary to perform the function specified in Sections 40 9XXX and shown on the Drawings. See Division 26 wire and cable sections for "uses permitted." Analog signal conductors and discrete signal conductors shall always be in separate conduits or cable tray compartments. Power wiring shall be in conduits and cable tray compartments separate from all signal wiring.
   1. The Contractor shall terminate field wiring for equipment specified under this section. The system integrator shall check instrument installation and field wiring before instrument devices are electrically powered by Contractor. Wires shall be terminated at terminal blocks with crimp type, preinsulated tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. All signal shields shall have only one ground point that shall be located at the closest control panel. Seal around all conductors inside conduits as they enter equipment. Use watertight seal (closed cell RTU foam type) entering or leaving every building, box, or instrument. Install conduit water relief or "weep" on the system side of all seals to prevent intrusion of water into the equipment.
   2. Spare Wiring: Signal and interlock wiring shall contain spare conductors in every raceway. Spare conductors shall be provided in pairs and shall be clearly and distinctly marked at every access point indicated where the pairs start and stop. The minimum number of spare pairs shall be 25 percent of the number of active pairs with a minimum of one spare pair.

C. Valves

1. General Application: Use gate and ball valves for shutoff duty; globe and ball valves for throttling duty.
2. Access: Locate valves for easy access and provide separate support where necessary.
3. Unions: Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown.
4. Stems: Install valves in horizontal piping with stem at or above the center of the pipe.
5. Clearance: Install valves in a position to allow full stem movement.

D. Threaded Connections
1. Procedure
   a. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
   b. Align threads at point of assembly.
   c. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
   d. Assemble joint, wrench-tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

E. Tagging
1. All instrumentation equipment shall be provided with identification tags in accordance with the plans and Division 26 Section “Electrical identification”. Each field instrument shall have a stainless steel tag.
2. The device tags shall be mounted using stainless steel screws.

3.3 ADJUSTING

A. Set Points: Alarm and control set points shall be adjusted to their operational values before the start of the field test.

B. Calibration: Calibration adjustments shall be performed before the start of the field test. Testing shall commence after calibration verification for each instrument is provided to the Engineer.

3.4 FIELD QUALITY CONTROL

A. Piping Tests: After piping systems have been put into service, inspect for leaks. Adjust pipes, valves, or fittings to stop leaks; replace equipment if leak persists.

B. Field Test
1. A technical representative of the system integrator and the Contractor shall perform a field test on the entire instrumentation and control system. All equipment provided by the system integrator and all interrelated equipment provided by other suppliers, such as pumps, blowers, valve operators, chemical feeders, motor controls, etc., shall be installed and operating properly before the test starts.
2. All test equipment and materials shall be provided by the system integrator.
3. As a minimum, the test shall consist of the following:
   a. All wiring shall be checked at each termination point for correct wire size, type, color, termination, and wire number.
   b. All instruments and devices shall be checked to verify compliance with the specifications and approved shop drawings. The calibration of analog devices shall be verified including the zero and span.

c. Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.
d. All digital inputs shall be activated at the field element to verify proper response on the OIT.
e. All analog inputs shall be tested at the field transmitter over a full range to verify proper response at OIT. Analog loops shall be verified at each termination point at 0, 25, 50, 75 and 100% signal levels.
f. All digital and analog outputs shall be forced, via the OIT, or PLC if necessary, to verify proper response at the final control element.
g. Communications shall be tested between all components, including existing equipment.
h. Verify proper calibration of all instruments by independent measurements, such as checking levels with a measuring rod or pole, performing drawdown tests on wells to check flow rates, performing laboratory tests on samples, etc.
i. Create temporary test conditions to simulate variations in process operation by throttling valves, controlling pump speed, shutting down process equipment, operating safety devices, etc. Where safety concerns or process limitations prohibit physical simulation and when agreed to by the Owner, simulated process signals may be used. Test conditions shall be sufficient to test the operation of every function of the instrumentation and control system including:
    1) Alarms and safety shutdowns.
    2) Equipment start/stop and speed controls.
    3) Pacing of chemical feed equipment.
    4) Recorders and indicators.
    5) Process controller operation and recovery from upsets.
    6) Programmable logic controller (PLC) or Supervisory Control and Data Acquisition (SCADA) system inputs and outputs.
    7) PLC or SCADA system programming.
j. The test shall be performed according to the test procedures submitted. As each phase of the test is completed, test data sheets shall be signed and dated. The test data sheets shall document any modifications to the control and alarm settings, process engineering unit changes, programming changes, wiring changes, problems encountered, and steps taken to solve the problems.
k. The commissioning effort shall be documented using forms similar to the sample Loop Validation/Inspection Tests form at the end of this Section.

3.5 CLEANING

A. Instrumentation System: The instrumentation system components shall be kept clean and free of dust during the storage, start-up, demonstration, and warranty period.

B. Control Panels and Consoles: Clean dust and dirt accumulation inside and outside control panels and consoles, on a monthly basis, during start-up and demonstration period.

3.6 DEMONSTRATION

A. General: The Contractor shall perform a 30-day operational demonstration of the complete instrumentation and control system. The demonstration shall conform to the following requirements. The 30-day operational demonstration shall not begin until the field test is completed and all problems and defects encountered during the field test have been corrected.

B. System Acceptance: System acceptance shall not occur until the entire instrumentation and control system has performed as a functioning unit continuously for 30 consecutive days without loss of control and monitoring function, except for periods of scheduled maintenance. Failure of any component, software function, or required function shall require a restart of the 30-day operational demonstration until 30 consecutive days of continuous operation have been completed.

C. Staffing: Provide for the services of a qualified service technician for the duration of the 30-day demonstration. The service technician shall be on call 24 hours per day, 7 days a week.

3.7 PROTECTION

A. The Contractor shall protect the instrumentation system components from water, dust, dirt, and corrosion during the start-up, demonstration, and warranty period.

3.8 INSTRUCTION OF PERSONNEL

A. Field Training: Training shall be conducted on all I&C equipment provided under the 40 9XXX series Sections, and related electrical and interfaces to equipment provided by other division sections. Training sessions shall be conducted as follows:
   1. Provide 40 hours of training by factory-authorized representative of equipment to Owner’s personnel.
   2. Training courses shall include hardware components emphasizing operation, calibration, maintenance, interface with other systems, and associated theory.
   3. Minimum Goals: Training shall incorporate operational requirements described in these specifications. Training shall provide the plant operations personnel with the following:
      a. Control set point and dead band modifications.
      b. Control system start-up and shutdown.
      c. Routine diagnostic checks and maintenance.
      d. Field instrument calibration and maintenance.
      e. Equipment diagnostic testing and replacement of failed parts.
   4. The process control system integrator shall submit a training program that provides the plant operations personnel a theoretical background and a broad range of related skills to achieve the listed goals. The instructor(s) shall be experienced in system applications similar to the equipment specified herein. The resumes of the training staff for instructing the plant operations personnel shall be available for review by the Owner. The plant operations personnel trainees shall be subjected to program testing, evaluation, and counseling. Study assignments shall be made and later reviewed by the instructors to the satisfaction of class attendees. Trainees shall be encouraged to freely ask questions during the instruction periods.
   5. The Contractor shall provide all classroom training courses and all hands-on training at the project site. Contractor shall provide tables, chairs, and all training documentation for training attendees.
   6. Provide text material for self-study and to supplement classroom lectures. The personnel attending the training courses shall be permitted to retain text materials for future reference.

B. The Contractor shall develop a training program tailored to the Owner's needs including type and quantity of treatment plant personnel, a curriculum of described courses, duration of courses, and training facilities. The Contractor shall submit for approval a detailed outline of the proposed training schedule, how the training courses are to be conducted, and estimated

dates for beginning and end of each training phase. The Contractor shall be responsible for the cost of the training program. The Owner shall be responsible for the trainee salaries and overhead costs.

C. Calibration Certificate Forms: See following forms.

SAMPLE
CALIBRATION CERTIFICATE

Job Name: _____ Contract No.: _____
Tag Number/Loop Number: _____
Loop Description: _____
Instrument Location: _____
Manufacturer: _____
Model Number _____
Adjustable Range: _____
Calibrated Range: _____
Remarks: _____

Installation Per Manufacturer's Requirements? Yes No
Installation Per Contract Documents? Yes No
If "No", explain: _____

Calibration Test:

	Input (Units)	Output (Units)	Accuracy
0%			
10%			
25%			
50%			
75%			
90%			
100%			

Switch Test:

	Setting	Deadband	Switch Point Upscale	Switch Point Downscale
Setpoint 1				
Setpoint 2				
Setpoint 3				
Setpoint 4				

CALIBRATION CERTIFICATE (cont.)

I hereby certify that the above information is correct and accurate, to the best of my knowledge, and that the instrument indicated above has been supplied, installed, calibrated, and tested in accordance with the manufacturer's recommendations and the Contract Documents, unless otherwise noted.

Receipt of this Calibration Certification shall in no way imply acceptance of any work or instrument supplied as a part of this Contract.

CONTRACTOR'S Signature: _____ Date: _____
CONTRACTOR'S Printed Name: _____

System Integrator's
Authorized Manufacturers
Representative Signature: _____ Date: _____

Representative Printed Name: _____
Phone Number: _____

Tester's Signature: _____ Date: _____
Tester's Printed Name: _____
Phone Number: _____

END OF SECTION 40 9000

SAMPLE LOOP VALIDATION/INSPECTION FORM

Client Name — Loop Validation / Inspection Test

Project Location:		
Contract Number:	**Loop Number/Description:**	**Tag Number:**
PLC Description:		**Page ____ of ____**

DISCRETE I/O CHECKOUT

DP Initials	I/O Point Description	PLC	OIT	HMI	Notes/Remarks

ANALOG I/O CHECKOUT

DP Initials	I/O Signal Description	PLC	OIT	HMI	Notes/Remarks

Span	Desired	Actual	% Variation
0%			
25%			
50%			
75%			
100%			

Span	Desired	Actual	% Variation
0%			
25%			
50%			
75%			
100%			

Loop Validated Signatures	CONTRACTOR	DESIGN PROFESSIONAL (DP)	OWNER'S REPRESENTATIVE
	Name:	Name:	Name:
	Initials: Date:	Initials: Date:	Initials: Date:

SECTION 40 9100

PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Scope:
   1. Contractor shall furnish, install, calibrate, test, adjust, and place into operation the primary sensors and field instruments as shown on the Drawings and specified herein to the satisfaction of Owner.
   2. The Drawings and Specifications illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping, and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, accessories, and labor required for a complete, workable, and integrated system.
   3. Contractor shall be responsible for installing in-line pressure and flow elements and for providing taps in the process piping systems for installation of other flow and pressure sensing instrumentation.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

C. Related Sections:
   1. Section 40 9513, Control Panels

1.2 REFERENCES

A. AMSE B40.100, Pressure Gauges and Gauge Attachments

B. ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

C. ASTM A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

D. ASTM A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

E. ASTM B88, Standard Specification for Seamless Copper Water Tube

F. National Accreditation of Measurement and Sampling (NAMAS)

G. NEMA 250, Enclosures for Electrical Equipment

H. National Institute of Standards and Technology (NIST)

1.3 SUBMITTALS

A. Comply with Section 40 9000, Instrumentation and Control System General Requirements

PART 2 - PRODUCTS

2.1 IDENTIFICATION TAGS

A. Type: White engraved phenolic

B. Function: Identify specific characteristics of all sensors and field instruments. All instruments, whether field or panel mounted, shall have an identification tag.

C. Performance Requirements:
1. Tag numbers of sensors and field instruments shall be as shown on the drawings and as specified. For items not shown or specifically tagged, the item tag number shall be established by the system supplier.
2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.
3. The tags shall be fastened to the device with self-tapping stainless steel screws. Where fastening with screws cannot be accomplished secure with 1/8 inch stranded stainless steel wire rope and secured with a crimp sleeve. Provide hole in end of tag for attachment of wire.
4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel. Panel mounted devices shall have the tag attached to the rear of the device.

D. Construction Features:
1. Tags shall be engraved with 3/16-inch letters and constructed as follows:
a. 1/8- inch thick laminated phenolic for engraving composed of core laminated on both sides with a matte (non-glare) finish cover sheet
b. Core to be black; cover sheet to be white
c. Mounting holes to be centered on width and 1/4 inch from each end

2.2 LEVEL INSTRUMENTATION

A. RADAR LEVEL METER
1. Type: Non-contact system using a microwave transmitter/receiver, a horn or rod antenna and a microprocessor-based signal processor. Frequency modulated continuous wave of electromagnetic energy is transmitted through the antenna towards the surface of the material to be measured and energy is reflected back in the form of echoes. The transit time of the reflected radar signal is measured and evaluated in the signal processor. The level (or volume) of the material is read out in engineering units.
2. System Performance Requirements:
a. Accuracy:
1) Less than 32 feet: +/- 0.6 inches or better
2) Greater than 32 feet: +/- 0.3 percent of span or better
b. Maximum range: 65 feet
c. Repeatability: +/- 0.1% or better
d. Frequency: 25 GHz
e. Modulation: Frequency Modulated Continuous Waveform (FMCW)
f. Power Requirements: 24 VDC loop power
g. Transmitter analog output: 4 to 20 mA, 750 ohm maximum load
h. Transmitter digital output protocol: HART

i. Ambient Temperature: +15 to 25°C

3. Required Features:
   a. Antenna:
      1) Mountings: Flange mounting
      2) Rod Antenna Material: PTFE
      3) Flange and mounting hardware material: Type 316 stainless steel
      4) Maximum transmitter power: 30 microwatts
   b. Transmitter/Processor:
      1) Enclosure: Copper-free Aluminum, epoxy coated, NEMA 6, IP67
      2) Operator Control: Illuminated LCD. Programming by keypad or non-invasive programming using handheld programmer or magnetized probe
      3) Memory: non-volatile ROM/EEPROM
   c. Accessories:
      1) Handheld programmer
4. Manufacturer and Model:
   a. Series SITRANS LR250 as manufactured by Siemens
   b. Or approved equal

B. LIQUID POINT-LEVEL SWITCH
1. Function: To sense specific level for a process fluid by means on RF admittance technology. An output relay is actuated when the sensing element comes in contact with the process fluid.
2. Features:
   a. Field selectable for low or high level detection.
   b. Sensing element material: Suitable for the process liquid.
   c. Mounting: ¾" NPT for mating to non-metallic flange.
   d. NEMA 4X/IP66 Housing
   e. Area classification: General purpose
3. Electrical Characteristics:
   a. Electronics mounted integral to sensor
   b. Single DPDT relay contacts rated at 5A @ 120VAC
   c. Relay time delay adjustable up to 60 seconds response time
   d. Input Power: 19-250VAC, 18-200VDC, auto sensing
4. Manufacturer and Model:
   a. Model ThePoint as manufactured by AMETEK Drexelbrook
   b. Or approved equal

C. FLOAT SWITCH
1. Type: Direct acting, pear shaped, eccentric weighted, displacement type liquid level sensor
2. Construction Features:
   a. Float Body: Hollow hermetically sealed, rigidly molded of polypropylene containing mechanical switch and eccentric metal weight
   b. Mechanical Switch: SPDT switch rated 10 A resistive at 120 VAC and 5 A resistive at 30 VDC
   c. Weight: Weight to cause sensor to hang straight down from cable when not immersed and only allow float to pivot when immersed in liquid of specific gravity 1.0. External weights or floats that completely rise to the surface will not be permitted.
   d. Electrical Cable:

1) Heavy duty, 3 conductor, flexible and submersible cable, sheathed in PVC or chlorinated polyethylene rubber and connected to float and switch with watertight seal
2) Manufacturer's continuous length cable furnished shall be of sufficient length to extend to junction box.

3. Manufacturer and Model:
   a. Model ENM-10 as manufactured by ITT Flygt
   b. Or approved equal

D. WET FLOOR DETECTION SWITCH
1. Type: A direct acting float that moves up and down a stationary stem or rod surrounded by a permeable shield for protection and to minimize sloshing. The float shall rise or lower with liquid level and activate a magnetic switch within the stem or rod.
2. Features:
   a. Float body: 316 Buna N with magnet in float for actuating switch in rod. Float shall rise when immersed in water.
   b. Mechanical switch inside of rod: Hermetically sealed reed switch
   c. Rod material: Type 316 stainless steel
   d. Slosh and Protection Shield: Polycarbonate Plastic
3. Manufacturer and Model:
   a. LS-270 Series as manufactured by Gems Sensors
   b. Or approved equal

E. WET FLOOR DETECTION SWITCH (CHEMICAL AREAS)
1. Function: To detect wet floors in the chemical containment areas.
2. Type: A direct acting float that moves up and down a stationary stem or rod. The float shall rise or lower with liquid level and activate a magnetic switch within the stem or rod.
3. All wetted components shall be fully compatible for continuous immersion in chemical solutions.
4. Features:
   a. Float body: CPVC with magnet in float for actuating switch in rod. Float rises when immersed in water.
   b. Mechanical switch inside of rod: Hermetically sealed reed switch.
   c. Rod material: CPVC
   d. Mounting Bracket: Provide a wall mount bracket constructed of chemically-compatible material. Bracket shall position detector as close to floor as possible and allow full adjustment of detector position.
5. Manufacturer and Model:
   a. LS-74780 Series as manufactured by Gems Sensors.
   b. Or approved equal

F. SUBMERSIBLE LEVEL TRANSMITTER
1. Type: Submersible piezoresistive element measuring the level with reference to atmospheric pressure.
2. Performance Requirements:
   a. Accuracy: +/- 0.25% full scale
   b. Range: See Schedule
   c. Power: 12-30VDC loop power
   d. Transmitter Output: 4-20mADC, 2-wire loop powered
   e. Temperature Range: 0-180°F
   f. Pressure Limit: 2x full scale

3. Required Features:
    a. Mounting: As shown on the drawings.
    b. Housing: 316SS with 1/2" NPT and ETFE Cable
    c. Electrical Protection: Lightning and Surge protection
4. Manufacturer and Model:
    a. Model PBLT2 by Dwyer Instruments
    b. Or approved equal

2.3 FLOW INSTRUMENTATION

A. MAGNETIC FLOWMETER

1. General:
    a. Flowtube: Produce low level, high impedance pulsed DC signal proportional to the rate of fluid flow using the principle of electromagnetic induction.
    b. Pulsed DC Magnetic Flow Transmitter: Drive the flowtube coils with pulsed DC power and convert the flowtube output signal into a DC current output proportional to the flow rate.
2. System (Flowtube and Transmitter) Performance Requirements:
    a. Flow Range: As specified in the Instrument Schedule
    b. System Accuracy (with Analog Output): +/- 0.55% of flow rate or better over range from 2 fps to 33 fps
    c. System Repeatability: +/- 0.15% of flow rate or +/- 0.15 fps, whichever is greater
    d. Drift: Complete 0 stability
    e. Minimum Fluid Conductivity Limit: 5 micromho per centimeter or less
    f. Transmitter Outputs:
        1) 4 to 20 mA, direct acting and isolated
        2) High accuracy, field adjustable scaled pulse output to drive local totalizer
    g. Power Consumption: Not to exceed 20 VA for flowtube and transmitter combined
    h. Operating Temperature: Suitable for operation with process fluid temperature from -23 to 140°F
    i. Pressure Rating: Greater than or equal to test pressure specified in Section 40 0513, Exposed Piping Installation, for appropriate piping system
3. Construction and Required Features:
    a. Flowtube:
        1) Type: Lined metal flowtubes
        2) Size: As specified in the Instrument Schedule
        3) Interchangeability: Ratio of flow velocity to voltage reference signals generated shall be identical for all meter sizes to permit interchangeability with transmitter without requiring circuit modifications.
        4) System accuracy specified above shall be proven by submittal of flow test curves of the actual meters being furnished.
        5) Test curves shall show a minimum of 8 equally spaced flow points. Tests shall be performed using water and a weight or volume tank, or reference meters that are traceable and calibrated to NAMAS or NIST standards.
        6) Tube Material:
            a) Meter tubes 12 inches and smaller: Type 304 stainless steel
            b) Metering tubes 14 inches and larger: Type 304 stainless steel, 0.125-inch wall thickness or greater
        7) Electrodes Material: Type 316 stainless steel, unless otherwise specified in the Instrument Schedule

8) Lining: Teflon®, Elastomer, Neoprene, or polyurethane unless otherwise specified in the Instrument Schedule
9) Enclosure:
a) Materials and Rating: Stainless steel, polyurethane coated sheet steel, or cast low-copper aluminum alloy NEMA 6P, submersible to 33 feet
b) Finish: Finish exterior, except for flange faces, with a high build epoxy paint
10) End Connections: ANSI Class 150 pounds flange suitable for mating with pipe specified
11) Electrical Connections: 1/2-inch NPT tapped holes for power conduit fitting and signal conduit fittings

b. Pulsed DC Magnetic Flow Transmitter:
1) Solid state construction
2) Pulse and analog output with superimposed HART communication protocol. Outputs shall be galvanically isolated from input and earth ground
3) Automatic zeroing feature making it unnecessary to zero the instrument before or after placing it in operation
4) Precalibrated span adjustment providing continuous span adjustment over entire range
5) Enclosure:
a) NEMA 4
b) Finish: Epoxy coating
6) Mounting:
a) All transmitter and driver electronics shall be remotely mounted from the flow tubes at locations shown on the Drawings.
b) Provide complete stainless-steel mounting hardware
c) Type of mounting (wall, support frame or pipe stand) as required
7) Local Indication:
a) 8-character minimum LCD with field selectable engineering units
8) Power Requirements: 115 VAC +/- 10%, 60 Hz, +/- 3 Hz power supply

c. Accessories:
1) Manufacturer's recommended cables of sufficient length for connection between flowtube and transmitter electronics
2) Type 316 stainless steel grounding rings for flowtubes
3) Type 316 stainless steel grounding straps
4) Provide a NEMA 4X rated 120 VAC power on-off switch.
5) Provide spool piece for replacement of each different size flow tube where no bypass piping is provided.
6) Provide 1 calibrator suitable to calibrate all flow tubes provided.

4. Manufacturer and Model:
a. Sitrans Series 5100 flow tube and 5000 Series transmitter as manufactured by Siemens
b. Or approved equal

B. CLAMP-ON FLOWMETER
1. General
a. The meter shall be a clamp-on design which mounts externally to the pipe and with no liquid contact.
b. The meter shall utilize the transit-time measurement technique and employ the use of two microprocessors.

c. The meter shall also employ an alternate Doppler measurement technique for liquids with high solid content. The meter shall automatically toggle from transit time to Doppler measurement if the signal decays due to high solids content and toggle back once the signal improves. The time delay for the toggle feature shall be programmable.
d. Transducers shall be supplied with multi-point wet flow calibration certificate and shall have an accuracy of +/- 1%.

2. Transducer Features
   a. Transducers shall have built-in RTD for measuring the transducer block temperature and automatically compensating for temperature effects including changes in fluid viscosity and density.
   b. Transducers shall be encased in stainless steel with an integral armored stainless steel jacketed TRIAX cable. The use of COAX and BNC cable is not acceptable.
   c. Transducers shall be mounted in a full sealed stainless steel mounting track and have the ability to be coupled using permanent coupling pads. Use of grease is not acceptable.
   d. Transducer markings shall be laser scribed and solvent resistant. Use of adhesive labels is not acceptable.
3. Meter features
   a. The meter shall have the ability to automatically recognize the transducers when they are connected.
   b. The meter shall not require a "zero calibration" in the field. The zero calibration shall be factory pre-set and certified prior to shipment.
   c. The meter shall have the ability to automatically calculate the Reynolds number and corresponding flow regime (laminar, turbulent, and transitional).
   d. The meter shall provide automatic liquid sonic velocity compensation, and have built in liquid tables for liquid viscosity and density settings.
   e. The meter electronics shall be housed in a NEMA4X enclosure and shall display flow rate, flow velocity, mass flow, total flow, signal strength, signal quality, liquid sonic velocity, and the flow regime.
   f. The meter shall be capable of outputting multiple 4-20ma signals, voltage 0-1 V or 0-10 V high precision frequency 0-1 kHz or 0-10 kHz galvanically isolated, RS-232, RS-484, binary output pulse of alarm for relay total and meter status.
   g. The meter shall have the ability to status alarm for conditions of fault, flow direction, sound velocity limit, and flow velocity limit.
   h. The meter shall have the ability to set the 4-20 ma signal to a settable status and alarm condition.
   i. The meter shall have RS-232 output and internal memory with a minimum storage of 100,000 data points.
4. Accessories
   a. Provide all necessary straps and anchors to affix the transducers to the pipe and meter to the wall.
   b. Provide all necessary cables for connection between the transducers and the meter.
5. Sizes and Ratings
   a. System Accuracy: ±1.0 percent of rate from 0 to 100 percent of range.
   b. Meter shall read within the prescribed accuracy with fluid velocities from 0.01 feet per second to 57 feet per second.
   c. Drift: Complete zero stability.
   d. Process Fluid Temperature: 40 to 120 deg F
6. Warranty

a. Strap on flowmeter shall include a minimum 1 year factory warranty. Field service shall be included at no additional cost during the warranty period.

7. Manufacturer: Subject to compliance with the requirements of this specification, available manufacturers of clamp-on flow meters include, but are not limited to, the following:
   a. Flexim 7407
   b. Or approved equal

C. CHEMICAL FLOWMETER

1. Provide flow sensors to assure that chemical is being delivered. Sensors shall be installed at the point of injection and shall operate from 50% to 150% of the typical service flow as show in the flow meter schedule.
2. Materials of Construction
   a. Body: 316 SST
   b. Pistons: Carbon
   c. Bearing: Rulon
   d. O-rings: Teflon
3. Minimum Accuracy:
   a. +/- 5% at flowrates of 7 to 29 mL/min
   b. +/- 10% at flowrate of 3 to 90 mL/min
4. Manufacturer:
   a. Max Machinery, Model 234, with 4-20 mA output

2.4 PRESSURE INSTRUMENTATION

A. DIGITAL PRESSURE TRANSMITTER/SWITCH

1. Type: Gauge pressure.
2. Function: Provide analog output signal directly proportional to sensed pressure.
3. Performance Specifications:
   a. Adjustable Range: See Instrument Schedule
   b. Number of Switches and Setpoints: One.
   c. Setpoint Accuracy: 0.5% of full range span.
   d. Power Supply: 10-36Vdc loop-power.
   e. Outputs:
      1) Analog: 4-20mAdc isolated.
      2) Discrete: SPST rated for 300mA @ 120VAC
4. Required Features:
   a. Repeatability: 0.1% of full range span.
   b. Programmable response time delay: 2 seconds minimum.
   c. Programmable for automatic or manual reset.
   d. Field adjustable setpoint over full range by means of external touchpad.
   e. Display: 0.5” 4-digit (minimum), LCD.
   f. Screw type terminals.
   g. ½” NPT female process connection.
   h. ½” NPT female electrical connection.
   i. Pressure sensor element shall be 316SS.
   j. NEMA 4X epoxy-coated aluminum enclosure.
   k. Programming and data shall be protected by non-volatile EEPROM.
5. Manufacturers:
   a. United Electric Controls, One Series.
   b. Or approved equal

B. PRESSURE TAPS, SENSING LINES, AND ACCESSORIES

1. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters:
   a. Material: Copper Water Tube, ASTM B88, Type L, drawn temper or annealed
   b. Pressure Rating: 150 psi
   c. Size: 1/2-inch outer diameter for water
   d. Connections: Brass Compression Type, "Swagelok" by Crawford, or approved equal
   e. Shut-off Valves:
      1) Type: Ball
      2) Pressure Rating: 150 psi
      3) Body, Ball and Stem: Brass
      4) Packing: High Density TFE
      5) Handle: Nylon with metal travel stops
      6) Support Rings: TFE coated brass
      7) End Connections: Removable "Swageloks"
      8) Model: Whitey Series 40 for water, or approved equal
   f. Manifolds:
      1) Type: 5-valve and 3-valve meter manifolds
      2) Materials: 316 SS Body, Bonnets and Stems; Delrin seats; Teflon Packing
      3) Manufacturer: Anderson-Greenwood, or approved equal
2. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters:
   a. Material: Type 316 Stainless Steel Tubing, ASTM A269, Medium Wall Thickness
   b. Pressure Rating: 150 psi
   c. Size: 3/8-inch outer diameter for air
   d. Connections: 316 Stainless Steel Compression Type, "Swagelok" by Crawford, or approved equal
   e. Shut-off Valves:
      1) Type: Ball
      2) Pressure Rating: 150 psi
      3) Body, Ball and Stem: Type 316 Stainless Steel
      4) Packing: High Density TFE
      5) Handle: Nylon with metal travel stops
      6) Support Rings: TFE coated Type 316 stainless steel
      7) End Connections: Removable "Swageloks"
      8) Model: Whitey Series 40 for air, or approved equal
3. Manifolds:
   a. Type: 5-valve and 3-valve meter manifolds
   b. Materials: Type 316 stainless steel Body, Bonnets and Stems; Delrin seats; Teflon Packing
   c. Manufacturer: Anderson-Greenwood, or approved equal
4. Pressure Tap Sensing Lines and Accessories for Pressure Switches and Pressure Gauges:
   a. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:
      1) Material and Fittings: Type 304L Stainless Steel Pipe (ASTM A312) and threaded fittings and adapters (ASTM A403) in accordance with Section 40 0513, Process Piping.
      2) Sizes: 1/2 inch minimum for main sensing piping and 1/4-inch gauge and switch connections
      3) Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Schedule in Section 40 0513, Process Piping.
      4) Accessories:

a) For applications not requiring diaphragm seals, provide separate 1/2-inch stainless steel threaded ball valve for each gauge and switch.
b) For applications requiring diaphragm seals, provide separate 1/2-inch threaded stainless-steel ball valve for seal process side shutoff. Ball valves shall be provided in accordance with the specifications in Section 40 0523, Process Valves, Gates, and Accessories.

b. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
1) Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. PVC pipe and fittings shall be provided in accordance with the requirements of Section 40 0513, Process Piping.
2) Sizes: 1/2 inch minimum for main process sensing piping and 1/4 inch for gauge and switch connections
3) Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 40 0513, Process Piping.
4) Accessories:
a) For copper piping system taps with or without seals, provide a separate 1/2-inch minimum threaded brass or bronze ball valve for each gauge and switch.
b) For PVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded PVC ball valve for process sensing line shutoff. Ball valves shall be provided in accordance with the specifications in Section 40 0523, Process Valves, Gates, and Accessories.

C. DIAPHRAGM SEAL
1. General: Furnish diaphragm seals for pressure gauges and switches at locations shown and as specified.
2. Required Features:
a. Provide fill/bleed screw to permit filling of instrument and diaphragm seal
b. Instrument Connection: 1/4-inch NPT
c. Process Connection: 1/2-inch NPT
d. Working Pressure Rating: Equal to or greater than the attached gauge or switch operating pressure specified in Exposed Piping Schedule in Section 40 0513, Process Piping, whichever is greater
e. Bolting Materials: Type 316 stainless steel
f. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
3. Construction Features:
a. Top Housing: Type 316 stainless steel
b. Diaphragms, O-rings and Gaskets:

Process Fluid	Diaphragm	O-Ring	Gasket
Chlorine Gas	Teflon	Teflon	Teflon
Chlorine Solution	Teflon	Teflon	Teflon
Alum	Teflon	Teflon	Teflon
Lime	316 SS	Teflon	Teflon
Sodium Hypochlorite	Teflon	Teflon	Teflon
Sludge	316 SS	Buna-N	Buna-S

c. Process Side Housing Material: 316 stainless steel for metallic piping; PVC or CPVC to match non-metallic piping
d. Sensing Liquid: Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Flurolube 63.

4. Assembly and Calibration:
   a. The complete diaphragm seal assembly, including gauge, switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch setpoints specified prior to shipment.
   b. CONTRACTOR shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gauge, switch or transmitter accuracy over the specified measurement range or at switch setpoints.
   c. Location and orientation of the gauges, switches and seal assemblies shall be coordinated with the actual piping and equipment installations so that gauges and indicators shall be easily read and accessed for maintenance by plant personnel.
5. Manufacturer and Model:
   a. Type 101 as manufactured by Ashcroft
   b. Or approved equal

2.5 TEMPERATURE INSTRUMENTATION

A. DIGITAL TEMPERATURE TRANSMITTER

1. Function: Provide analog output signal directly proportional to sensed temperature.
2. Performance Specifications:
   a. Adjustable Range: See Instrument Schedule
   b. Number of Switches and Setpoints: One.
   c. Setpoint Accuracy: 0.5% of full range span.
   d. Power Supply: 10-36Vdc loop-power.
   e. Outputs:
      1) Analog: 4-20mAdc isolated.
      2) Discrete: SPST solid state rated for 600mA @ 120VAC
3. Required Features:
   a. Repeatability: 0.1% of full range span.
   b. Programmable response time delay: 2 seconds minimum.
   c. Programmable for automatic or manual reset.
   d. Field adjustable setpoint over full range by means of external touchpad.
   e. Display: 0.5” 4-digit (minimum), LCD.
   f. Screw type terminals.
   g. ½” NPT female process connection.
   h. ½” NPT female electrical connection.
   i. Temperature sensor element shall be 316SS.
   j. NEMA 4X epoxy-coated aluminum enclosure.
   k. Programming and data shall be protected by non-volatile EEPROM.
4. Sensor: Provide local sensor unless shown otherwise on the Drawings.
5. Manufacturers:
   a. United Electric Controls, One Series.
   b. Or approved equal

2.6 ANALYTICAL INSTRUMENTATION

A. RESIDUAL CHLORINE ANALYZER

1. Description: Amperometric chlorine probe for reagentless free chlorine measurement.
2. Analyzer
   a. Number of Sensors: Up to four (4)
   b. Number of Analog Outputs: Up to four (4)
   c. Display: 4" minimum, color.
   d. Power: 120V
   e. Output: 4-20 mA
   f. Enclosure: NEMA 4X FRP
   g. Maximum Dimensions: 11" x 13" x 6" (W x H x D)
   h. Note: Where possible combine multiple sensors/probes on a single analyzer/transmitter.
3. Probe
   a. Type: Membrane-covered amperometric three-electrode system
   b. Measured: Free residual chlorine
   c. Probe range: 0.05 -5 mg/L
   d. Resolution: 0.01 mg/L
   e. Reproduction: ±5%
   f. Stability: -1% per month (without calibration)
   g. Working electrode: Gold catholde
   h. Counter electrode: SST anode
   i. Reference electrode: silver/silver halide
   j. Temperature range: 41 to 113 degrees F
   k. pH Range: 4-9 s.u.
   l. First polarization time: 120 minutes
   m. Re-polarization time: 30 minutes
   n. Calibration: Manual using DPD
   o. Housing Material: PVC
4. Accessories:
   a. Flow cell: Provide a polycarbonate flow cell and backplate. Provide dual flow cell in instances where two probes are required. Mount using 304 SST hardware.
5. Spare Parts:
   a. Two (2) membrane caps per chlorine sensor.
6. Product and Manufacturer:
   a. Chemtrac HydroACT HA4 analyzer, CP4 probe.
   b. Foxcraft FX-CL-F analyzer, 301254X probe.

B. pH/OXIDATION REDUCTION POTENTIAL (ORP) ANALYZERS

1. Description: Three electrode (process, reference, and ground) differential pH/ORP probe and a microprocessor-based analyzer/transmitter designed to measure pH/ORP of the sample and produce a proportional output signal linear to the pH/ORP.
2. Analyzer
   a. Number of Sensors: 4
   b. Number of Analog Outputs: 4
   c. Display: 4" minimum, color.
   d. Power: 120V
   e. Output: 4-20 mA
   f. Enclosure: NEMA 4X
   g. Maximum Dimensions: 11" x 13" x 6" (W x H x D)
   h. Note: Where possible combine multiple sensors/probes on a single analyzer/transmitter.

3. pH Probe
    a. Type: W-type rod membrane, pH electrode
    b. Measured: pH
    c. Probe range: 0 – 14 s.u.
    d. Slope: 95 – 102%
    e. Stability: < -0.01 s.u. per hour (without calibration)
    f. Reproducibility: < 0.01 s.u
    g. Working electrode: Gold catholde
    h. Counter electrode: SST anode
    i. Reference electrode: silver/silver halide
    j. Temperature range: 41 to 113 degrees F
    k. pH Range: 4-9 s.u.
    l. First polarization time: 120 minutes
    m. Re-polarization time: 30 minutes
    n. Calibration: Manual using DPD
    o. Housing Material: PVC
4. Accessories:
    a. Flow cell: Provide a polycarbonate flow cell and backplate. Provide dual flow cell in instances where two probes are required. Mount using 304 SST hardware.
5. Materials
    a. Sensor
        1) Body and salt bridge: PEEK.
        2) Junction: Kynar.
        3) Process electrode: Glass (pH), glass and platinum (ORP).
        4) Ground electrode: Titanium.
        5) O-ring seals: Viton.
    b. Analyzer/Transmitter Enclosure: NEMA 4X.
    c. Insertion Mounting Assembly: Stainless steel, type 316.
6. Ratings and Performance
    a. Sensor
        1) Range: 0 to 14 pH; -1500 to +1500 mV ORP.
        2) Sensitivity: +/- 0.01 pH; +/- 0.5 mV ORP.
        3) Stability: 0.03 pH; 2mV ORP per 24 hours, non cumulative.
        4) Operating temperature: 23 to 158 degrees F.
        5) Maximum pressure: 100 psi at 158 degrees.
        6) Maximum flow rate: 10 fps.
    b. Analyzer/Transmitter
        1) Repeatability: 0.05% of span.
        2) Stability: 0.05% of span for 24 hours, non-cumulative.
        3) Analog outputs: 4 to 20 mA isolated.
        4) Ambient temperature range: -4 to 104 deg F.
        5) Relative humidity: 0 to 95% non-condensing.
        6) Input power: 120 V a. c., 35W maximum.
        7) Output contacts: 120 V a. c., 5 Amp resistive maximum.
        8) Analog outputs: 500 Ohms maximum impedance.
7. Product and Manufacturer
    a. Hach pHD Series pH/ORP sensor and sc200 analyzer/transmitter.
    b. Rosemount 389VP sensor and 1056 analyzer/transmitter.

C. CONDUCTIVITY ANALYZERS

1. Description: Inductive conductivity sensor that induces a low current in a solution and measures the magnitude of the current to determine the conductivity.
2. Features
    a. Sensor
        1) Non-contacting inductive sensor.
        2) Internal platinum RTD for temperature compensation.
        3) Insertion mounting.
        4) Nominal 1/2-inch bore diameter.
    b. Analyzer/Transmitter
        1) Solid state, microprocessor-based.
        2) Non-volatile memory for all user settings.
        3) Capable of operating with up to two sensors.
        4) Two independent PID controllers.
        5) Plug and play operation, automatically detects sensor type.
        6) Built-in data logger, stores 6 months of data at 15-minute intervals with 2 sensors.
        7) Two analog outputs.
        8) Three SPDT alarm/control relays.
        9) LCD graphic display with LED backlighting.
3. Accessories
    a. Digital gateway.
    b. Extension cable.
    c. Insertion mounting assembly with ball valve, 2 inch NPT.
4. Materials
    a. Sensor Body: Teflon.
    b. Analyzer/Transmitter Enclosure: NEMA 4X.
    c. Insertion Mounting Assembly: Stainless steel, type 316.
5. Ratings and performance
    a. Sensor
        1) Range: 0-200 up to 0-2,000,000 microSiemens/cm.
        2) Sensitivity: +/- 0.01 pH; +/- 0.5 mV ORP.
        3) Stability: 0.03 pH; 2mV ORP per 24 hours, non cumulative.
        4) Operating temperature: 14 to 392 deg F.
        5) Maximum pressure: 200 psi.
        6) Maximum flow rate: 10 fps.
    b. Analyzer/Transmitter
        1) Repeatability: 0.05% of span.
        2) Stability: 0.05% of span for 24 hours, non-cumulative.
        3) Analog outputs: 4 to 20 mA isolated.
        4) Ambient temperature range: -4 to 104 deg F.
        5) Relative humidity: 0 to 95% non-condensing.
        6) Input power: 120 V a. c., 35W maximum.
        7) Output contacts: 120 V a. c., 5 Amp resistive maximum.
        8) Analog outputs: 500 Ohms maximum impedance.
6. Product and Manufacturer
    a. Hach 3700 sensor and sc200 analyzer/transmitter.
    b. Rosemount 400VP and 1056 analyzer/transmitter.

D. FLUORIDE ANALYZER
1. Description: Ion selective electrode to monitor fluoride ion concentration in potable water.

2. Analyzer
    a. Number of Sensors: 1
    b. Number of Analog Outputs: 1
    c. Display: 3 digit red LED.
    d. Power: 120V
    e. Output: 4-20 mA
    f. Enclosure: NEMA 4X Polycarbonate
    g. Maximum Dimensions: 11” x 8” x 5” (W x H x D)
3. Probe
    a. Type: Ion selective electrode (ISE)
    b. Measured: Fluoride
    c. Probe range: 0 - 10 mg/L
    d. Resolution: 0.01 mg/L
    e. Accuracy: ±0.2%
    f. Reference half cell: Silver/silver chloride, saturated KCl
    g. Primary Junction: Porous ceramic, statured KCl in crossed linked polymer
    h. Secondary Junction: Solid-state non-porous cross-linked conductive polymer embedded in HDPE/Kynar support matrix, excess saturated KCl salt system in cross linked polymer
    i. Temperature range: 41 to 122 degrees F
    j. pH Range: 5.5 - 9.5 s.u.
    k. Calibration: Manual (1 point offset)
    l. Material: Radel R-5000 NT
4. Accessories:
    a. Flow cell: Provide a 12” x 24” x ½” (H x W x D) PVC panel for mounting with a 0-25 psi pressure reducer, 0 – 5 gph rotometer with SST valve, brass barbed connectors for ¼” ID tubing, ½” SCH 80 PVC piping to keep sensor tip wet, 1” PVC pipe tee with twist lock sensor receptacle, and inlet and backpressure PVC ball valves.
5. Product and Manufacturer:
    a. Foxcraft FX-300-F analyzer, SF-8T-UL probe.

E. PHOSPHATE ANALYZER
1. Description: Analyzer to monitor orthophosphate concentration in potable water.
2. Analyzer/Probe
    a. Number of Sensors: 1
    b. Number of Analog Outputs: 1
    c. Power: 120V
    d. Output: 4-20 mA
    e. Serial Interface: RS-232
    f. Enclosure: NEMA 4X FRP
    g. Maximum Dimensions: 26” x 10” x 7” (H x W x D)
    h. Measured: Orthophosphate (as PO_4 or as PO_4-P)
    i. Probe range (as PO_4): 0.09 - 9 mg/L
    j. Probe range (as PO_4-P): 0.03 - 3 mg/L
    k. Cycle Time: 5 – 9999 minutes
    l. Accuracy: ±2% or 2x detection limit
    m. Temperature range: 41 to 131 degrees F
3. Accessories:

a. Reagents: Provide a sufficient amount of VMO reagent suitable for 12 months of operation at a 5 minute sample cycle. Provide reagent line priming package, reagent and cleaning solution bottle with connection lines, and reagent rack.

4. Product and Manufacturer:
   a. ChemScan mini oP

2.7 SCHEDULES

A. Schedule: See attachment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Items shall be inspected for damage upon delivery to the site.

B. Damaged components shall not be installed.

3.2 INSTALLATION

A. Contractor shall require the system supplier to furnish the services of qualified factory-trained servicemen to assist in the installation of the instrumentation and control system equipment.

B. Install each item in accordance with manufacturer's recommendations in accordance with the Contract Documents. Transmitters and instruments which require access for periodic calibration or maintenance shall be mounted so they are accessible while standing on the floor. Care shall be taken in the installation to ensure sufficient space is provided between instruments and other equipment or piping to allow for easy removal and servicing.

C. All items shall be mounted and anchored using stainless steel hardware unless otherwise noted.

D. All field instruments shall be rigidly secured to walls, stands, or brackets as required by the manufacturer and as shown on the Contract Drawings.

E. Conform to all applicable provisions of the NEMA standards, NEC, and local, State, and Federal codes when installing the equipment and interconnecting wiring.

END OF SECTION 40 9100

SECTION 40 9443

PLANT CONTROL SYSTEM (FAWTP)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

B. Related Sections: The following sections contain requirements that relate to this section.
1. Division 26 Section “Basic Electrical Requirements”.
2. Division 26 Section “Basic Electrical Materials”.
3. Division 26 Section “Signal and Communication Cables”.
4. Division 26 Section “Wires, Cables, and Connectors”.
5. Division 40 Section “Instrumentation – General”.
6. Division 40 Section “Control Panels”.

1.2 DESCRIPTION OF WORK

A. General: Provide all labor, tools, equipment, and materials necessary for a complete and operational Plant Control System in accordance with the plans and as specified herein.

B. Contractor shall furnish all labor, materials, and components, and shall provide all design, assembly, testing, and start-up services required to provide a complete and operational programmable controller system (referred to herein as PLC) as specified and shown on the Drawings. The system includes, but is not necessarily limited to the following:
1. Processor modules.
2. Communication equipment.
3. Input/output (I/O) modules.
4. Operator interface equipment.
5. Mounting racks.
6. Power supplies.
7. Programming equipment.
8. Software.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of the National Electrical Code (NEC) and all other applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
1. National Electrical Manufacturers Association (NEMA).
2. Institute of Electrical and Electronic Engineers (IEEE).
3. American National Standards Institute (ANSI).
4. National Fire Protection Association (NFPA).
5. Underwriters' Laboratories (UL).
6. International Society for Measurement and Control (ISA).

C. Qualifications
   1. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of programmable logic controllers (PLCs) whose products have been in satisfactory use in similar service for not less than 5 years.
   2. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with materials and equipment similar to items specified herein.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data for all components.

B. Materials List: Submit a bill of materials listing quantities, manufacturer's name, and catalog numbers.

C. Wiring Diagrams: Submit wiring diagrams showing all connections for all equipment furnished under this section. Wire, terminal, and component labeling shall follow established facility conventions where applicable.

D. System Hardware and Software Documents: Furnish a system block diagram, I/O drawings, and control strategy descriptions. Turn over all factory software documentation and manuals to the Engineer after completion of field testing.

E. Dimensional Drawings: Furnish dimensional drawings for each piece of equipment to be provided.

F. Program Documentation: Submit annotated printouts of all PLC and Human Machine Interface (HMI) programs. Provide copies of all PLC and HMI programs on a flash drive.

G. Manufacturer's Data Sheet: Provide manufacturer's data sheet on all equipment including model numbers, serial numbers, ranges, scales, and a detail of each component.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Store the items furnished under this section in a manner that meets the requirements of the manufacturer until they can be installed. Use all means necessary to protect the material of this section before, during, and after installation, and to protect the installed work and materials of all other trades.

1.6 DEFINITIONS

A. Training Day: A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday.

1.7 SCADA ALLOWANCE

A. The Contractor shall include in the bid an allowance for the purchase of computers, accessories, peripherals, and/or furniture for the Owner. These components shall be provided by the System Integrator. The Owner shall be able to select the computers, accessories, peripherals, and/or furniture during the shop drawing review process with technical input from the System Integrator.

PART 2 - PRODUCTS

2.1 SCADA SYSTEM

A. Programmable Logic Controller (PLC) Components:
   1. Processor Rack:
      a. Processor Module: 1769-L36ER
      b. Digital Input Module: 1769-IA16, 1769-IA8I when isolation required
      c. Digital Output Module: 1769-OA8
      d. Analog Input Module: 1769-IF4I
      e. Analog Output Module: 1769-OF4CI
      f. Power Supply: 1769-PA4
      g. DIN Rail mounted
   2. Remote I/O:
      a. Communication Adapter: 1794-AENT
      b. Digital Input Modules: 1794-IA16 with 1794-TB3 terminal base unit
      c. Digital Output Modules: 1794-OA8I with 1794-TBNF terminal base unit
      d. Analog Input: 1794-IF4I with 1794-TB3 terminal base unit
      e. Analog Output: 1794-OF4I with 1794-TB3 terminal base unit
      f. Provide fusing for field wiring per manufacturer's installation instructions.
      g. DIN Rail mounted
   3. Manufacturers:
      a. All components shall be manufactured by Allen-Bradley or an Encompass Partner.

B. Operator Interface Terminal (OIT):
   1. Features:
      a. Touch screen flat display
      b. LED backlit LCD
      c. 24-bit 16.7M colors
      d. Size: 15" diagonal nominal, unless otherwise noted
      e. Resolution: 1024x768, minimum
      f. Communications: Ethernet/IP, USB
      g. SD card slot
      h. NEMA 12
      i. Real-time battery backed clock
      j. Memory: 1 GB RAM and 1 GB user storage
      k. Input Power: 120VAC
   2. Manufacturers:
      a. Allen-Bradley, PanelView 5510

PART 3 - EXECUTION

3.1 CUSTOM PROGRAMMING

A. Custom Programming of all vendor provided control panels, including their PLCs and OITs, shall be provided by that vendor under the applicable specification section of the associated equipment.
   1. Provide database spreadsheets for peer-to-peer communication coordination between other onsite PLCs that need to share data.
   2. Provide database spreadsheets for Plant HMI/SCADA communication coordination.
   3. Provide annotated copies of all PLC programs.

4. Provide an electronic copy of all PLC and OIT programming files for the Owner on a flash drive. Format shall be as required to reload into PLC memory. Logic version shall be the final program after all equipment has been installed and commissioned and Operational Demonstration is complete and successful to the Owner's approval.

B. Custom Programming of non-vendor provided control panels, including their PLCs and OITs, will be provided by the Owner.

C. Custom Programming of plant's existing HMI/SCADA will be provided by the Owner.

D. Graphic Screens
1. Submit all graphic screens for Owner review and comment when sixty percent complete.
2. Provide navigation controls on all screens to allow movement between screens.
3. Conform to NFPA 79, Industrial Machinery on colors for indicators and controls.
4. Conform to Owner standards for colors of process equipment and piping.
5. Utilize industry standard symbols or graphically realistic drawings for process equipment.
6. Provide a separate screen for each group of process equipment.
7. At a minimum, provide the following screens:
   a. Process Overview
   b. Individual Control Graphic for each associated piece of equipment/device
   c. Alarm Summary Screens
   d. Equipment Runtimes Screen
   e. Totalizers Screen
   f. (10) Analog Signal Trending Screens – Owner Directed

E. Global Programmed Control Strategies
1. Meet with Plant Personnel before start of programming
   a. Determine time of day for resetting of daily flow totalizers.
   b. Determine the status (turn off or maintain last state) of each piece of equipment that is controlled by the PLC in the event of a PLC failure.
   c. Security Levels for all screens.
2. Display all alarms at the OIT.
3. Provide means to acknowledge all alarms at the OIT.
4. Provide alarms for PLC failure and network failure.
5. Totalize the number of starts for all process equipment and display on the OIT.
6. All process setpoints displayed on OIT screens.
7. All process setpoints adjustable from the OIT screens with correct security level.
8. Perform a runtime calculation for all process equipment and display at the OIT.
9. Display rate, total, and daily total for all flows at the OIT.

3.2 EXAMINATION

A. Verification of Conditions: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Discrepancies: In the event any discrepancies are discovered, immediately notify the Owner's Representative in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 PREPARATION

A. Protection
   1. All equipment and materials shall be packed at the factory to protect each item from damage during shipment and storage.
   2. Provide blocking and cushioning materials to prevent damage during shipment.
   3. Panel mounted instruments and equipment to be installed inside enclosures, panels, or consoles shall be mounted and assembled at the panel manufacturer's facility.

3.4 INSTALLATION

A. General: Install equipment, as indicated, with manufacturer's written instructions and with recognized industry practices.

3.5 FIELD QUALITY CONTROL

A. Inspection: Provide for services of a qualified representative of the manufacturer to inspect and approve installation.

B. Tests: Upon completion of all inspections, and prior to acceptance, perform field tests outlined in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

C. Operational Demonstration: After completion of the field test, perform a 30-day operational demonstration as specified in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.6 DEMONSTRATION

A. General: When all required tests have been performed and prior to final acceptance, the Contractor shall perform a 30 day operational demonstration in accordance with the requirements of Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.7 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.

B. Quantity: Provide spares for each type of module listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
   1. Processor Modules
   2. Power Supply
   3. Digital Input Modules
   4. Digital Output Modules
   5. Analog Input Modules
   6. Analog Output Modules
   7. Analog Input/Analog Output Modules
   8. Flex I/O Modules
   9. Flex I/O Module Terminal Blocks

C. Provide (6) OIT protective screen overlays.

D. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no cost.

3.8 PLC SYSTEM TRAINING

A. General.
   1. Provide a training course customized for the control system hardware.
   2. Provide training on the operation and maintenance of the control system hardware.
   3. Provide training manuals for each attendee plus two additional manuals in archival preservation at the project site.
   4. Include the following in each manual.
      a. An agenda
      b. Defined objectives for each lesson.
   5. Provide all equipment, materials, and supplies used in the training.
   6. For guidance in planning the required instruction, assume that attendees will have a high school education or equivalent and basic electrical maintenance knowledge.

B. Location, duration, and schedule.
   1. Teach the course at the project site.
   2. Provide one day of training for five personnel designated by the Owner.
   3. Conduct training after completion of the Contractor's field testing.

3.9 INPUT/OUTPUT SCHEDULE

A. Abbreviations
   1. AI = Analog Input
   2. AO = Analog Output
   3. CPU = Processor
   4. DI = Digital Input
   5. DO = Digital Output
   6. RIO = Remote I/O Communications

B. Installed spare inputs and outputs (I/O): In addition to the I/O listed below, provide a minimum of 10 percent installed.
   1. All SPARE I/O shall be wired to terminal blocks within the PLC enclosure.

END OF SECTION 40 9443

SECTION 40 9443

PLANT CONTROL SYSTEM (RARWTP)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

B. Related Sections: The following sections contain requirements that relate to this section.
1. Division 26 Section “Basic Electrical Requirements”.
2. Division 26 Section “Basic Electrical Materials”.
3. Division 26 Section “Signal and Communication Cables”.
4. Division 26 Section “Wires, Cables, and Connectors”.
5. Division 40 Section “Instrumentation – General”.
6. Division 40 Section “Control Panels”.

1.2 DESCRIPTION OF WORK

A. General: Provide all labor, tools, equipment, and materials necessary for a complete and operational Plant Control System in accordance with the plans and as specified herein.

B. Contractor shall furnish all labor, materials, and components, and shall provide all design, assembly, testing, and start-up services required to provide a complete and operational programmable controller system (referred to herein as PLC) as specified and shown on the Drawings. The system includes, but is not necessarily limited to the following:
1. Processor modules.
2. Communication equipment.
3. Input/output (I/O) modules.
4. Operator interface equipment.
5. Mounting racks.
6. Power supplies.
7. Programming equipment.
8. Software.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of the National Electrical Code (NEC) and all other applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
1. National Electrical Manufacturers Association (NEMA).
2. Institute of Electrical and Electronic Engineers (IEEE).
3. American National Standards Institute (ANSI).
4. National Fire Protection Association (NFPA).
5. Underwriters' Laboratories (UL).
6. International Society for Measurement and Control (ISA).

C. Qualifications
   1. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of programmable logic controllers (PLCs) whose products have been in satisfactory use in similar service for not less than 5 years.
   2. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with materials and equipment similar to items specified herein.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data for all components.

B. Materials List: Submit a bill of materials listing quantities, manufacturer's name, and catalog numbers.

C. Wiring Diagrams: Submit wiring diagrams showing all connections for all equipment furnished under this section. Wire, terminal, and component labeling shall follow established facility conventions where applicable.

D. System Hardware and Software Documents: Furnish a system block diagram, I/O drawings, and control strategy descriptions. Turn over all factory software documentation and manuals to the Engineer after completion of field testing.

E. Dimensional Drawings: Furnish dimensional drawings for each piece of equipment to be provided.

F. Program Documentation: Submit annotated printouts of all PLC and Human Machine Interface (HMI) programs. Provide copies of all PLC and HMI programs on a flash drive.

G. Manufacturer's Data Sheet: Provide manufacturer's data sheet on all equipment including model numbers, serial numbers, ranges, scales, and a detail of each component.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Store the items furnished under this section in a manner that meets the requirements of the manufacturer until they can be installed. Use all means necessary to protect the material of this section before, during, and after installation, and to protect the installed work and materials of all other trades.

1.6 DEFINITIONS

A. Training Day: A training day is defined as 8 hours of classroom and hands-on instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday.

1.7 SCADA ALLOWANCE

A. The Contractor shall include in the bid an allowance for the purchase of computers, accessories, peripherals, and/or furniture for the Owner. These components shall be provided by the System Integrator. The Owner shall be able to select the computers, accessories, peripherals, and/or furniture during the shop drawing review process with technical input from the System Integrator.

PART 2 - PRODUCTS

2.1 SCADA SYSTEM

A. Programmable Logic Controller (PLC) Components:
   1. Rack Mounted:
      a. Processor Module: 1756-L81E
      b. Digital Input Module: 1756-IA16I
      c. Digital Output Module: 1756-OW16I
      d. Analog Input Module: 1756-IF8I
      e. RTD Analog Input Module: 1756-IR12
      f. Analog Output Module: 1756-OF8I
      g. Communication Module: 1756-EN2T
      h. Power Supply: 1756-PA75/B
      i. Chassis: 1756-A17
   2. Protocol Gateway:
      a. Model as required for native protocol to Ethernet/IP conversion for quantity of connected devices.
      b. DIN Rail mounted
   3. Manufacturers:
      a. All components shall be manufactured by Allen-Bradley or an Encompass Partner.

B. Operator Interface Terminal (OIT):
   1. Features:
      a. Touch screen flat display
      b. LED backlit LCD
      c. 24-bit 16.7M colors
      d. Size: 15” diagonal nominal, unless otherwise noted
      e. Resolution: 1024x768, minimum
      f. Communications: Ethernet/IP, USB
      g. SD card slot
      h. NEMA 12
      i. Real-time battery backed clock
      j. Memory: 1 GB RAM and 1 GB user storage
      k. Input Power: 120VAC
   2. Manufacturers:
      a. Allen-Bradley, PanelView 5510

2.2 SCHEDULES

A. Schedule: See attachment.

PART 3 - EXECUTION

3.1 CUSTOM PROGRAMMING

A. Custom Programming of all vendor provided control panels, including their PLCs and OITs, shall be provided by that vendor under the applicable specification section of the associated equipment.
   1. Provide database spreadsheets for peer-to-peer communication coordination between other onsite PLCs that need to share data.
   2. Provide database spreadsheets for Plant HMI/SCADA communication coordination.

3. Provide annotated copies of all PLC programs.
4. Provide an electronic copy of all PLC and OIT programming files for the Owner on a flash drive. Format shall be as required to reload into PLC memory. Logic version shall be the final program after all equipment has been installed and commissioned and Operational Demonstration is complete and successful to the Owner's approval.

B. Custom Programming of non-vendor provided control panels, including their PLCs and OITs, will be provided by the Owner.

C. Custom Programming of plant's existing HMI/SCADA will be provided by the Owner.

D. Variable Frequency Drives
1. Provide programming for all VFDs connected to the network.
2. Read and display the contents of a minimum of eight registers in each VFD.
3. Coordinate with the Owner prior to the start of programming to select the register to be displayed.

E. Graphic Screens
1. Submit all graphic screens for Owner review and comment when sixty percent complete.
2. Provide navigation controls on all screens to allow movement between screens.
3. Conform to NFPA 79, Industrial Machinery on colors for indicators and controls.
4. Conform to Owner standards for colors of process equipment and piping.
5. Utilize industry standard symbols or graphically realistic drawings for process equipment.
6. Provide a separate screen for each group of process equipment.
7. Group related screens in a logical manner such as by building, plant flow, liquid stream/solids stream, etc.
8. At a minimum, provide the following screens:
    a. Plant Overview
    b. NF Building Overview
    c. Break Tank Pumps Overview
    d. NF Feed Pumps Overview
    e. NF Skids Overview
    f. Corrosion Inhibitor System Overview
    g. Sodium Hydroxide System Overview
    h. Sodium Bisulfite System Overview
    i. Antiscalant System Overview
    j. Break Tank Pump Control Graphics
    k. NF Feed Pump Control Graphics
    l. Corrosion Inhibitor Chemical Equipment Control Graphics
    m. Corrosion Inhibitor Chemical Feed Control Graphic
    n. Sodium Hydroxide Chemical Equipment Control Graphics
    o. Sodium Hydroxide Chemical Feed Control Graphic
    p. Sodium Bisulfite Chemical Equipment Control Graphics
    q. Sodium Bisulfite Chemical Feed Control Graphic
    r. Antiscalant Chemical Equipment Control Graphics
    s. Antiscalant Chemical Feed Control Graphic
    t. Chemical Feed Building Overview
    u. Sodium Hypochlorite System Overview
    v. Fluoride System Overview
    w. Sodium Hypochlorite Chemical Equipment Control Graphics
    x. Sodium Hypochlorite Chemical Feed Control Graphic

y. Fluoride Chemical Equipment Control Graphics
z. Fluoride Chemical Feed Control Graphic
aa. Electrical Service Overview
bb. Alarm Summary Screens
cc. Equipment Runtimes (with resets) Screen
dd. Totalizers Screen
ee. (10) Analog Signal Trending Screens – Owner Directed
ff. (10) Overview/Control Screens – Owner Directed

F. Global Programmed Control Strategies
1. Meet with Plant Personnel before start of programming to determine:
a. Time of day for resetting of daily totalizers
b. Security Levels for all screens
c. The master PCS clock and approach to sync network devices
2. Display all alarms at the HMI.
3. Provide means to acknowledge all alarms at the HMI.
4. Provide alarms for PLC failure and network failure.
5. Totalize the number of starts for all process equipment and display on the plant HMI.
6. All process setpoints displayed on HMI screens and read back for confirmation.
7. All process setpoints adjustable from the HMI screens with correct security level.
8. Perform a runtime calculation for all process equipment at PLC and display at the HMI.
9. Display rate, total, and daily total for all process flows at the HMI.
10. Display all process levels at the HMI.
11. Store average daily flow rates and peak hourly flow rates of all flow meters one year or more at SCADA.
12. One year of data shall be stored for trending with data saved every 15 minutes. Daily totals shall also be saved. Each year, or at any time, the Operator shall be able to copy this data to a CD or DVD in a spreadsheet format.
13. All inline instrumentation shall be shown with instantaneous values on the HMI. One year of data shall be stored for trending. Each year, or at any time, the Operator shall be able to copy this data to a CD or DVD in a spreadsheet format.
14. All data shall be automatically graphed when chosen by the operator. These trending graphs shall not reset when closed or when the operator switches between data screens or other graphs.
15. All bits/elements in PLC logic shall be commented. If not used, then comment as SPARE.
16. SCADA historical graphs shall include programming to constantly refresh to appear as a “live, historical trend“.

G. SCADA Programming Funtional Requirements
1. The Functional Descriptions below are intended to aid in defining the scope of work for PLC/OIT/HMI programming. These functional descriptions are intended to be supplemental to the requirements as shown on the Drawings. Hardwired interlocks for equipment control may not be described below. Hardwired interlocks shall be mimicked in PLC logic.
2. Where the referenced detail applies to multiple, similar equipment controls, only one is described. Control for associated equipment is similar.
3. Reference the PLC I/O schedules. The PLC I/O shall be utilized by PLC/HMI programming, as required, to allow the respective equipment to function as described by the Contract Documents.

a. All alarm and equipment status monitoring PLC I/O inputted into the Plant Control System (PCS) shall be annunciated via the HMI.

4. All references to set points as "adjustable" below shall include the capability to adjust the set point via the HMI.

5. FUNCTIONAL DESCRIPTION INDEX:
   a. "6. NF BUILDING BREAK TANK"
   b. "7. NF BUILDING SOFTENING SYSTEM"
   c. "8. CORROSION INHIBITOR CHEMICAL FEED SYSTEM"
   d. "9. SODIUM HYDROXIDE CHEMICAL FEED SYSTEM"
   e. "10. SODIUM BISULFITE CHEMICAL FEED SYSTEM"
   f. "11. ANTISCALANT CHEMICAL FEED SYSTEM"
   g. "12. SODIUM HYPOCHLORITE CHEMICAL FEED SYSTEM"
   h. "13. FLUORIDE CHEMICAL FEED SYSTEM"
   i. "14. HIGH SERVICE PUMPS"
   j. "15. EXISTING PROCESS CONTROL MODIFICATIONS"
   k. "16. EMERGENCY POWER"
   l. "17. CRITICAL ALARMS"

6. NF BUILDING BREAK TANK
   a. Break Tank 1 Level
      1) General: Used to continuously monitor the liquid level in the Break Tank.
      2) Control:
         a) Local: None
         b) PCS: None
      3) Logic Interlocks/Permissives:
         a) Used for control of existing groundwater wells.
      4) Monitoring:
         a) Local: Instantaneous level indication
         b) PCS: Break Tank 1 Level
      5) Alarms:
         a) Local: None
         b) PCS: High-High, High, Low, Low-Low Break Tank 1 Level, Loss of Signal
   b. Break Tank 1 Low Cutoff Level
      1) General: Used to protect the Break Tank Pumps from operating when level is too low.
      2) Control:
         a) Local: None
         b) PCS: None
      3) Logic Interlocks/Permissives:
         a) None
      4) Monitoring:
         a) Local: None
         b) PCS: None
      5) Alarms:
         a) Local: None
         b) PCS: Break Tank 1 Low Level

7. NF BUILDING SOFTENING SYSTEM
   a. Break Tank Pump 1

1) General: Used to source water from the Break Tank to the NF Building process (softening and/or bypass).
2) Control:
    a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
    b) VFD: The VFD frequency can be manually adjusted utilizing the potentiometer or VFD HIM module at the VFD.
    c) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of Break Tank Pump 1 via the HMI.
        (1) PC MANUAL: The operator shall have the ability to manually start/stop and adjust the frequency of Break Tank Pump 1.
        (2) AUTO: Break Tank Pump 1 shall be automatically controlled via PLC programming. Break Tank Pump 1 speed shall be varied maintain an operator entered NF Feed Pump Suction Header Pressure setpoint. Break Tank Pumps shall be assigned a Lead, Lag 1, Lag 2, or Standby role and start/stop as needed to meet the setpoint.
3) Logic Interlocks/Permissives:
    a) NF Bypass Valve must not be closed for the pump to operate.
4) Monitoring:
    a) Local: Running, Stopped
    b) VFD: Running, Stopped, Frequency, Amps, Volts
    c) PCS: Remote, Running, Stopped, Frequency, Amps, Volts, VFD LOR Switch Position
5) Alarms:
    a) Local: General Alarm
    b) VFD: VFD Fault Alarm
    c) PCS: Motor High Temperature, High Discharge Pressure, VFD Fault, Loss of Signal

b. Break Tank Pump 1 Discharge Pressure
1) General: Used to continuously monitor the discharge pressure for Break Tank Pump 1.
2) Control:
    a) Local: None
    b) PCS: None
3) Logic Interlocks/Permissives:
    a) None
4) Monitoring:
    a) Local: Instantaneous pressure indication
    b) PCS: Break Tank Pump 1 Discharge Pressure
5) Alarms:
    a) Local: None
    b) PCS: High-High, High, Low, Low-Low Break Tank Pump 1 Discharge Pressure, Loss of Signal

c. NF Bypass Flow
1) General: Used to continuously monitor the NF Bypass flow rate.
2) Control:

a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) Reference the NF Bypass Flow Control Loop

4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: NF Bypass Flow

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Bypass Flow, Loss of Signal

d. NF Bypass Flow Control Valve

1) General: Used to divert flow around the membrane skids.

2) Control:
a) Local: With the LOCAL-STOP-REMOTE selector switch at the actuator in the LOCAL position, the operator can open or close the valve by using the OPEN-CLOSE selector switch at the actuator. With the LOCAL-STOP-REMOTE selector switch at the actuator in the STOP position, the actuator will stop and maintain its current position.
b) PCS: With the LOCAL-STOP-REMOTE selector switch at the actuator in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the NF Bypass Flow Control Valve via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually set a desired position.
(2) AUTO: The NF Bypass Flow Control Valve shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED, HARDNESS, and PERCENT control modes.
(a) FIXED: The valve position shall vary in order to maintain an operator entered desired NF Bypass Flow rate.
(b) HARDNESS: The valve position shall vary in order to maintain an operator entered desired Blended Water Hardness.
a. If no Break Tank Pumps are operating and a plant run command is active, the valve shall move to the operator entered plant startup initial position and shall remain at that position until a Break Tank Pump starts operating.
b. Flow rate = [(BW flowrate x BW hardness) – (NFP flowrate x NFP hardness)] / NFF hardness
(c) PERCENT: The valve position shall vary in order to maintain an operator entered desired NF Bypass Flow rate as a percentage of Blended Water Flow.
a. If no Break Tank Pumps are operating and a plant run command is active, the valve shall move to the operator entered plant startup

initial position and shall remain at that position until a Break Tank Pump starts operating.

3) Logic Interlocks/Permissives: None
4) Monitoring:
   a) Local: Opened, Closed, Position
   b) PCS: Remote, Opened, Closed, Position
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal

e. Break Tank Pumps Discharge Header Pressure
1) General: Used to continuously monitor the pressure for Break Tank Pump Discharge Header.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous pressure indication
   b) PCS: Break Tank Pumps Discharge Header Pressure
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Break Tank Pumps Header Discharge Pressure, Loss of Signal

f. Cartridge Filter 1 Differential Pressure
1) General: Used to monitor if the Cartridge Filter needs cleaned.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous differential pressure indication
   b) PCS: Cartridge Filter 1 Differential Pressure
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Cartridge Filter 1 Differential Pressure, Loss of Signal

g. NF Feed ORP (Pre-Injection) Level
1) General: Used to continuously monitor the ORP level of the NF Feed water prior to chemical injection.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Used for chemical feed dosing calculations.
4) Monitoring:
   a) Local: Instantaneous ORP level indication
   b) PCS: NF Feed ORP (Pre-Injection) Level
5) Alarms:

a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed ORP (Pre-Injection) Level, Loss of Signal

h. NF Feed Pumps Suction Header Pressure
1) General: Used to continuously monitor the pressure for NF Feed Pumps Suction Header.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Used for Break Tank Pump speed control.
4) Monitoring:
a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pumps Suction Header Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pumps Suction Header Pressure, Loss of Signal

i. NF Feed ORP (Post-Injection) Level
1) General: Used to continuously monitor the ORP level of the NF Feed water after chemical injection.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous ORP level indication
b) PCS: NF Feed ORP (Post-Injection) Level
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed ORP (Post-Injection) Level, Loss of Signal

j. NF Feed Pump 1 Suction Pressure
1) General: Used to continuously monitor the pressure for NF Feed Pump 1 Suction.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pump 1 Suction Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pump 1 Suction Pressure, Loss of Signal

k. NF Feed Pump 1
1) General: Used to source water to the membrane skids.
2) Control:

a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) VFD: The VFD frequency can be manually adjusted utilizing the potentiometer or VFD HIM module at the VFD.
c) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of NF Feed Pump 1 via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop and adjust the frequency of NF Feed Pump 1.
(2) AUTO: NF Feed Pump 1 shall be automatically controlled via PLC programming. NF Feed Pump 1 speed shall be varied as called for by the NF Skids Master PLC.

3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: Running, Stopped
b) VFD: Running, Stopped, Frequency, Amps, Volts
c) PCS: Remote, Running, Stopped, (2) Vibration Sensors, (2) Motor Bearing Temps, Frequency, Amps, Volts, VFD LOR Switch Position
5) Alarms:
a) Local: General Alarm
b) VFD: VFD Fault Alarm
c) PCS: Motor High Temperature, (2) High Vibration Alarms, (2) High Bearing Temp Alarm, Low Suction Pressure, High Discharge Pressure, VFD Fault, Loss of Signal

l. NF Feed Pump 1 Discharge Pressure
1) General: Used to continuously monitor the pressure for NF Feed Pump 1 Discharge.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pump 1 Discharge Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pump 1 Discharge Pressure, Loss of Signal

m. Degasifier 1
1) General: Used to remove gases from the water before entering the clearwell.
2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the blower via the START/STOP pushbuttons.

b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of Degasifier 1 via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop Degasifier 1.
(2) AUTO: Degasifier 1 shall be automatically controlled via PLC programming. Degasifier 1 shall operate whenever the plant is running.

3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote
5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

n. Degasifier 1 Inlet Screen Differential Pressure
1) General: Used to monitor if Degasifier 1 Screen needs cleaned.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous differential pressure indication
b) PCS: Degasifier 1 Screen Differential Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Degasifier 1 Inlet Screen Differential Pressure, Loss of Signal

o. Blended Water Flow
1) General: Used to continuously monitor the Blended Water flow rate.
2) Control:
a) Local: None
b) PCS: Operator shall have the ability to select MAINTENANCE, FLOWMETER, or SUM TOTAL as the BW Flow signal source via the HMI.
(1) MAINTENANCE: The operator shall have the ability to enter in a flow value during flowmeter maintenance to reduce impact on chemical feed systems.
(2) FLOWMETER: The signal from this flowmeter is used.
(3) SUM TOTAL: The sum of all Skid Discharge Flows plus the NF Bypass Flow signal is used.
3) Logic Interlocks/Permissives:
a) Used for the chemical feed dosing calculations.
4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: Blended Water Flow
5) Alarms:
a) Local: None

b) PCS: High-High, High, Low, Low-Low Blended Water Flow, Loss of Signal

p. Blended Water pH
1) General: Used to continuously monitor the pH level of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Used for chemical feed dosing calculations.
4) Monitoring:
a) Local: Instantaneous pH indication
b) PCS: Blended Water pH
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water pH, Loss of Signal

q. Blended Water Chlorine Residual
1) General: Used to continuously monitor the chlorine residual of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous Chlorine Residual indication
b) PCS: Blended Water Chlorine Residual
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Chlorine Residual, Loss of Signal

r. Blended Water Fluoride Residual
1) General: Used to continuously monitor the fluoride residual of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous Fluoride Residual indication
b) PCS: Blended Water Fluoride Residual
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Fluoride Residual, Loss of Signal

s. Blended Water Phosphate Residual
1) General: Used to continuously monitor the phosphate residual of the Blended Water.
2) Control:
a) Local: None

b) PCS: None

3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous Phosphate Residual indication
   b) PCS: Blended Water Phosphate Residual
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Blended Water Phosphate Residual, Loss of Signal

t. NF Concentrate Conductivity
1) General: Used to continuously monitor the conductivity of the skid concentrate.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous conductivity indication
   b) PCS: NF Concentrate Conductivity
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low NF Concentrate Conductivity, Loss of Signal

u. NF Concentrate pH
1) General: Used to continuously monitor the pH level of the NF Concentrate.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous pH indication
   b) PCS: NF Concentrate pH
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low NF Concentrate pH, Loss of Signal

v. NF Skid Control Interface
1) General: All control of individual NF Skids, Membrane Cleaning System, and associated equipment is performed by the NF Skids Master PLC. Custom programming requirements for that vendored system are specified under Section 466340. Programming requirements described below are provided under this Section for NF Building ACP PLC/OIT and SCADA.
2) Operator shall have the ability to enter the following water quality parameters for NF Feed and NF Permeate. These values will be used to determine the NF Bypass flowrate when operated in HARDNESS mode.
   a) Total Hardness in NF Feed (THNFF = 366 mg/L as $CaCO_3$
   b) Total Hardness in NF Permeate (THNFP = 10.8 mg/L as $CaCO_3$
3) PLC shall calculate and SCADA shall indicate and trend the following:

a) Total NF Feed flow rate (Total NFF = NFP + NFC)
b) NF Bypass Flow (NFB = NFP x %NFB).
c) Indicate Raw Water Flow Rate (RW = NFF + NFB).
d) Actual %NFB (%NFB = NFB / BLW)
(1) NFB from flow meter
(2) BLW = NFP flow meters from skids + NFB flow meter
(3) THBLW = [(NFB x THNFF) + (NFP x THNFP)] / BW

4) All Skid OIT and MCS screen information and operator entry shall be duplicated at SCADA.

w. NF Process Start/Stop

1) Control: Operator shall have the ability to place the softening process on automated Start/Stop control. If enabled, the plant shall start if the existing clearwell level drops below an operator adjustable setpoint. The plant shall shutdown if the clearwell level rises above an operator adjustable setpoint. Operator shall have the ability to select which clearwell level to use as the primary control signal.

2) When the plant startup is auto initiated:
a) Open NF Bypass Valve to initial setpoint.
b) Start Chemical Feed Systems.
c) Start Break Tank Pump.
d) Start UV System.
e) Start NF Feed Pumps and NF Skids (in multiples of two). The quantity of skids needed shall be based on NF Skid Call Level setpoints.

3) When the plant shutdown is auto initiated:
a) NF Skids and NF Feed Pumps shall perform a permeate flush or forward flush before stopping.
b) Break Tank Pumps shall continue to operate until all NF Skids and NF Feed Pumps have stopped.
c) Stop UV System.
d) Close NF Bypass Valve.
e) Stop Chemical Feed Systems.

8. CORROSION INHIBITOR CHEMICAL FEED SYSTEM

a. Corrosion Inhibitor Storage Tank 1 Level

1) General: Used to continuously monitor the liquid level in Corrosion Inhibitor Storage Tank 1.

2) Control:
a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Instantaneous level indication
b) PCS: Corrosion Inhibitor Storage Tank 1 Level

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Corrosion Inhibitor Storage Tank 1 Level, Loss of Signal

b. Corrosion Inhibitor Storage Tank 1 Outlet Valve

1) General: Used to isolate Corrosion Inhibitor Storage Tank 1 from the outlet header.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (4) PC MANUAL: The operator shall have the ability to open or close the valve.
      (5) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

c. Corrosion Inhibitor Storage Tank 1 Recirc Valve
1) General: Used to direct chemical to Corrosion Inhibitor Storage Tank 1 from the transfer pump.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

d. Corrosion Inhibitor Transfer Pump
1) General: Used to pump Corrosion Inhibitor chemical between tanks.
2) Control:

a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Corrosion Inhibitor Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Corrosion Inhibitor Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

e. Corrosion Inhibitor Day Tank Inlet Valve

1) General: Used to direct chemical to Corrosion Inhibitor Day Tank from the transfer pump.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

f. Corrosion Inhibitor Day Tank High Level

1) General: Used to prevent overfilling the day tank.

2) Control:
a) Local: None.
b) PCS: None.

3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Corrosion Inhibitor Day Tank High Level

g. Corrosion Inhibitor Day Tank Weight
1) General: Used to continuously monitor the weight of the Corrosion Inhibitor Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Corrosion Inhibitor Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Corrosion Inhibitor Day Tank Weight, Loss of Signal

h. Corrosion Inhibitor Feed Pump 1
1) General: Used to inject Corrosion Inhibitor into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
      (2) AUTO: Corrosion Inhibitor Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
         (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
         (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint.
3) Logic Interlocks/Permissives:
   a) Corrosion Inhibitor Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:

a) Local: Fault
b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Corrosion Inhibitor Chemical Transfer Sequence
1) General: Used for automated control of transferring chemical between tanks.
2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
(1) TRANSFER:
a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.
(2) RECIRC:
a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Corrosion Inhibitor Feed Room Emergency Eyewash/Shower Flow Switch
   1) General: Used to detect an activation of the emergency eyewash/shower.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives: None
   4) Monitoring:
      a) Local: None
      b) PCS: None
   5) Alarms:
      a) Local: None
      b) PCS: Corrosion Inhibitor Feed Room Emergency Eyewash/Shower Activated

k. Corrosion Inhibitor Containment Area Wet Floor Switch
   1) General: Used to detect a Corrosion Inhibitor tank leak.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives: None
   4) Monitoring:
      a) Local: None
      b) PCS: None
   5) Alarms:
      a) Local: None
      b) PCS: Corrosion Inhibitor Containment Area Wet Floor Switch Activated

9. SODIUM HYDROXIDE CHEMICAL FEED SYSTEM

a. Sodium Hydroxide Storage Tank 1 Level
   1) General: Used to continuously monitor the liquid level in Sodium Hydroxide Storage Tank 1.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Instantaneous level indication
      b) PCS: Sodium Hydroxide Storage Tank 1 Level
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Storage Tank 1 Level, Loss of Signal

b. Sodium Hydroxide Storage Tank 1 Outlet Valve
   1) General: Used to isolate Sodium Hydroxide Storage Tank 1 from the outlet header.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None
      b) PCS: None

c. Sodium Hydroxide Storage Tank 1 Recirc Valve
   1) General: Used to direct chemical to Sodium Hydroxide Storage Tank 1 from the transfer pump.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.

(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hydroxide Chemical Transfer Sequence

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Sodium Hydroxide Transfer Pump

1) General: Used to pump Sodium Hydroxide chemical between tanks.

2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Sodium Hydroxide Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hydroxide Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

e. Sodium Hydroxide Day Tank Inlet Valve

1) General: Used to direct chemical to Sodium Hydroxide Day Tank from the transfer pump.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.

(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

f. Sodium Hydroxide Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
   a) Local: None.
   b) PCS: None.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Sodium Hydroxide Day Tank High Level

g. Sodium Hydroxide Day Tank Weight
1) General: Used to continuously monitor the weight of the Sodium Hydroxide Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Sodium Hydroxide Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Day Tank Weight, Loss of Signal

h. Sodium Hydroxide Feed Pump 1
1) General: Used to inject Sodium Hydroxide into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.

(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Hydroxide Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired Blended Water pH setpoint.

3) Logic Interlocks/Permissives:
a) Sodium Hydroxide Day Tank Low-Low Level Alarm must be inactive for pump to operate.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Fault
b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Sodium Hydroxide Carrier Water Valve

1) General: Used to convey chemical for injection into the process stream.

2) Control:
a) Local: None
b) PCS: The operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall be open when any Sodium Hydroxide Feed Pump is operating.

3) Logic Interlocks/Permissives:
a) None

4) Monitoring:
a) Local: None
b) PCS: Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

j. Sodium Hydroxide Chemical Transfer Sequence

1) General: Used for automated control of transferring chemical between tanks.

2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
(1) TRANSFER:
a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.

b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.

h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

k. Sodium Hydroxide Feed Room Emergency Eyewash/Shower Flow Switch
1) General: Used to detect an activation of the emergency eyewash/shower.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hydroxide Feed Room Emergency Eyewash/Shower Activated

l. Sodium Hydroxide Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Hydroxide tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hydroxide Containment Area Wet Floor Switch Activated

m. Sodium Hydroxide Feed Room Temperature
1) General: Used to continuously monitor the temperature of the Sodium Hydroxide Feed Room.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous temperature indication
b) PCS: Sodium Hydroxide Feed Room Temperature
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Feed Room Temperature, Loss of Signal

10. SODIUM BISULFITE CHEMICAL FEED SYSTEM

a. Sodium Bisulfite Storage Tank 1 Level
   1) General: Used to continuously monitor the liquid level in Sodium Bisulfite Storage Tank 1.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Instantaneous level indication
      b) PCS: Sodium Bisulfite Storage Tank 1 Level
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low Sodium Bisulfite Storage Tank 1 Level, Loss of Signal

b. Sodium Bisulfite Storage Tank 1 Outlet Valve
   1) General: Used to isolate Sodium Bisulfite Storage Tank 1 from the outlet header.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Bisulfite Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None
      b) PCS: None

c. Sodium Bisulfite Storage Tank 1 Recirc Valve
   1) General: Used to direct chemical to Sodium Bisulfite Storage Tank 1 from the transfer pump.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.

(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Bisulfite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Bisulfite Chemical Transfer Sequence

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Sodium Bisulfite Transfer Pump

1) General: Used to pump Sodium Bisulfite chemical between tanks.

2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Sodium Bisulfite Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Sodium Bisulfite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Bisulfite Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

e. Sodium Bisulfite Day Tank Inlet Valve

1) General: Used to direct chemical to Sodium Bisulfite Day Tank from the transfer pump.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.

(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Bisulfite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

f. Sodium Bisulfite Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
   a) Local: None.
   b) PCS: None.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Sodium Bisulfite Day Tank High Level

g. Sodium Bisulfite Day Tank Weight
1) General: Used to continuously monitor the weight of the Sodium Bisulfite Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Sodium Bisulfite Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Bisulfite Day Tank Weight, Loss of Signal

h. Sodium Bisulfite Feed Pump 1
1) General: Used to inject Sodium Bisulfite into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.

(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Bisulfite Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired NF Feed ORP (Pre-Injection) setpoint.

3) Logic Interlocks/Permissives:
a) Sodium Bisulfite Day Tank Low-Low Level Alarm must be inactive for pump to operate.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Fault
b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Sodium Bisulfite Chemical Transfer Sequence

1) General: Used for automated control of transferring chemical between tanks.

2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
(1) TRANSFER:
a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.
(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Sodium Bisulfite Feed Room Emergency Eyewash/Shower Flow Switch

1) General: Used to detect an activation of the emergency eyewash/shower.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None

b) PCS: Sodium Bisulfite Feed Room Emergency Eyewash/Shower Activated

k. Sodium Bisulfite Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Bisulfite tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Bisulfite Containment Area Wet Floor Switch Activated

l. Sodium Bisulfite Feed Room Temperature
1) General: Used to continuously monitor the temperature of the Sodium Bisulfite Feed Room.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous temperature indication
b) PCS: Sodium Bisulfite Feed Room Temperature
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Bisulfite Feed Room Temperature, Loss of Signal

11. ANTISCALANT CHEMICAL FEED SYSTEM
a. Antiscalant Transfer Pump
1) General: Used to pump Antiscalant chemical between tanks.
2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Antiscalant Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Antiscalant Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
a) Reference the Antiscalant Chemical Transfer Sequence.
4) Monitoring:

a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

b. Antiscalant Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
a) Local: None.
b) PCS: None.
3) Logic Interlocks/Permissives:
a) Reference the Antiscalant Chemical Transfer Sequence.
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Antiscalant Day Tank High Level

c. Antiscalant Day Tank Weight
1) General: Used to continuously monitor the weight of the Antiscalant Day Tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Antiscalant Chemical Transfer Sequence.
4) Monitoring:
a) Local: Instantaneous weight indication
b) PCS: Antiscalant Day Tank Weight
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Antiscalant Day Tank Weight, Loss of Signal

d. Antiscalant Feed Pump 1
1) General: Used to inject Antiscalant into the water for treatment.
2) Control:
a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Bisulfite Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.

(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint using the sum of all Skid Inlet Flows.

3) Logic Interlocks/Permissives:
   a) Antiscalant Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

e. Antiscalant Injection Flow
   1) General: Used to detect that Antiscalant is being injected into the process stream.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) An Antiscalant Feed Pump must be operating for alarm logic to be active.
      b) Antiscalant flow must be present for an NF Skid to operate.
   4) Monitoring:
      a) Local: None
      b) PCS: None
   5) Alarms:
      a) Local: None
      b) PCS: Antiscalant No Flow Alarm

f. Antiscalant Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
      b) PCS: The operator shall be able to fill the day tank automatically using PLC programming.
         (1) DAY TANK FILL:
            a. The operator shall select the source storage tank and enter a Stop weight setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the transfer pump shall operate until the Stop weight is reached.
            d. Once the weight is reached, the transfer pump shall stop.
            e. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
            f. Day Tank High Level Alarm must be inactive for the transfer pump to start.
            g. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.

h. All applicable equipment must not have any active alarms in order to initiate the transfer.

12. SODIUM HYPOCHLORITE CHEMICAL FEED SYSTEM
    a. Sodium Hypochlorite Storage Tank 1 Level
        1) General: Used to continuously monitor the liquid level in Sodium Hypochlorite Storage Tank 1.
        2) Control:
            a) Local: None
            b) PCS: None
        3) Logic Interlocks/Permissives:
            a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
        4) Monitoring:
            a) Local: Instantaneous level indication
            b) PCS: Sodium Hypochlorite Storage Tank 1 Level
        5) Alarms:
            a) Local: None
            b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Storage Tank 1 Level, Loss of Signal
    b. Sodium Hypochlorite Storage Tank 1 Outlet Valve
        1) General: Used to isolate Sodium Hypochlorite Storage Tank 1 from the outlet header.
        2) Control:
            a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
            b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
                (3) PC MANUAL: The operator shall have the ability to open or close the valve.
                (4) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.
        3) Logic Interlocks/Permissives:
            a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
        4) Monitoring:
            a) Local: Opened, Closed
            b) PCS: Remote, Opened, Closed
        5) Alarms:
            a) Local: None
            b) PCS: None
    c. Sodium Hypochlorite Storage Tank 1 Recirc Valve
        1) General: Used to direct chemical to Sodium Hypochlorite Storage Tank 1 from the transfer pump.
        2) Control:
            a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.

b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Sodium Hypochlorite Dilution Water Flow

1) General: Used to continuously monitor the Sodium Hypochlorite Dilution Water flow rate.

2) Control:
a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Dilution Control Loop.

4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: Sodium Hypochlorite Dilution Water Flow

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Dilution Water Flow, Loss of Signal

e. Sodium Hypochlorite Storage Tank 1 Dilution Water Valve

1) General: Used to direct dilution water to Sodium Hypochlorite Storage Tank 1 to lower the solution concentration.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Dilution Control Loop.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Dilution Control Loop.

4) Monitoring:
a) Local: Opened, Closed

b) PCS: Remote, Opened, Closed

5) Alarms:
   a) Local: None
   b) PCS: None

f. Sodium Hypochlorite Transfer Pump
1) General: Used to pump Sodium Hypochlorite chemical between tanks.
2) Control:
   a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
   b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
      (2) AUTO: Sodium Hypochlorite Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Sodium Hypochlorite Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Alarm
   b) PCS: Motor High Temperature, Motor Overload

g. Sodium Hypochlorite Day Tank Inlet Valve
1) General: Used to direct chemical to Sodium Hypochlorite Day Tank from the transfer pump.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:

a) Local: None
b) PCS: None

h. Sodium Hypochlorite Day Tank Level
1) General: Used to continuously monitor the liquid level in Sodium Hypochlorite Day Tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
a) Local: Instantaneous level indication
b) PCS: Sodium Hypochlorite Day Tank Level
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Day Tank Level, Loss of Signal

i. Sodium Hypochlorite Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hypochlorite Day Tank High Level

j. Sodium Hypochlorite Disinfection Feed Pump 1
1) General: Used to inject Sodium Hypochlorite into the water for disinfection treatment.
2) Control:
a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Hypochlorite Disinfection Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.

(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Blended Water Flow.

3) Logic Interlocks/Permissives:
   a) Sodium Hypochlorite Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

k. Sodium Hypochlorite Oxidation Feed Pump 1
1) General: Used to inject Sodium Hypochlorite into the water for oxidation treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
      (2) AUTO: Sodium Hypochlorite Oxidation Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
         (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
         (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Total Filter Flow.
3) Logic Interlocks/Permissives:
   a) Sodium Hypochlorite Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Opened, Closed, Position
   b) PCS: Remote, Opened, Closed, Position
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal

l. Sodium Hypochlorite Chemical Transfer Sequence
1) General: Used for automated control of transferring chemical between tanks.
2) Control:
   a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.

b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.

(1) TRANSFER:

a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.

d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Level Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Switch Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

m. Sodium Hypochlorite Dilution Control Loop
1) General: Used for automated control of adding dilution water to storage tanks to reduce the concentration of the solution.
2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to add dilution water.
b) PCS: The operator shall be able to add dilution water automatically using PLC programming.
(1) Dilution Water Sequence:
a. The operator shall select which storage tanks to add dilution water to and enter a GALLONS setpoint.
b. The applicable Storage Tank Dilution Water Valves will open.
c. Once the GALLONS setpoint has been reached, the valves shall close.
d. Applicable Storage Tank(s) High Level Alarm(s) must be inactive for the sequence to start.
e. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
f. All applicable equipment must not have any active alarms in order to initiate the sequence.

n. Sodium Hypochlorite Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Hypochlorite tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hypochlorite Containment Area Wet Floor Switch Activated

o. Sodium Hypochlorite Feed Room Temperature
1) General: Used to continuously monitor the temperature of the Sodium Hypochlorite Feed Room.

2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous temperature indication
   b) PCS: Sodium Hypochlorite Feed Room Temperature
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Feed Room Temperature, Loss of Signal

13. FLUORIDE CHEMICAL FEED SYSTEM

a. Fluoride Storage Tank 1 Level
   1) General: Used to continuously monitor the liquid level in Fluoride Storage Tank 1.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Instantaneous level indication
      b) PCS: Fluoride Storage Tank 1 Level
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low Fluoride Storage Tank 1 Level, Loss of Signal

b. Fluoride Storage Tank 1 Outlet Valve
   1) General: Used to isolate Fluoride Storage Tank 1 from the outlet header.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None

b) PCS: None

c. Fluoride Storage Tank 1 Recirc Valve
   1) General: Used to direct chemical to Fluoride Storage Tank 1 from the transfer pump.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None
      b) PCS: None

d. Fluoride Transfer Pump
   1) General: Used to pump Fluoride chemical between tanks.
   2) Control:
      a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
      b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
         (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
         (2) AUTO: Fluoride Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Fluoride Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Running, Stopped
      b) PCS: Running, Stopped, Remote
   5) Alarms:
      a) Local: Alarm
      b) PCS: Motor High Temperature, Motor Overload

e. Fluoride Day Tank Inlet Valve

1) General: Used to direct chemical to Fluoride Day Tank from the transfer pump.
2) Control:
    a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
    b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
        (1) PC MANUAL: The operator shall have the ability to open or close the valve.
        (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
    a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
    a) Local: Opened, Closed
    b) PCS: Remote, Opened, Closed
5) Alarms:
    a) Local: None
    b) PCS: None

f. Fluoride Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
    a) Local: None
    b) PCS: None
3) Logic Interlocks/Permissives:
    a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
    a) Local: None
    b) PCS: None
5) Alarms:
    a) Local: None
    b) PCS: Fluoride Day Tank High Level

g. Fluoride Day Tank Weight
1) General: Used to continuously monitor the weight of the Fluoride Day Tank.
2) Control:
    a) Local: None
    b) PCS: None
3) Logic Interlocks/Permissives:
    a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
    a) Local: Instantaneous weight indication
    b) PCS: Fluoride Day Tank Weight
5) Alarms:
    a) Local: None
    b) PCS: High-High, High, Low, Low-Low Fluoride Day Tank Weight, Loss of Signal

h. Fluoride Feed Pump 1
   1) General: Used to inject Fluoride into the water for treatment.
   2) Control:
      a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
      b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
         (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
         (2) AUTO: Fluoride Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
            (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
            (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Blended Water Flow.
   3) Logic Interlocks/Permissives:
      a) Fluoride Day Tank Low-Low Level Alarm must be inactive for pump to operate.
   4) Monitoring:
      a) Local: Running, Stopped
      b) PCS: Running, Stopped, Remote
   5) Alarms:
      a) Local: Fault
      b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Fluoride Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
      b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
         (1) TRANSFER:
            a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
            d. Once both opened, the transfer pump shall operate until the Stop level is reached.

e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Fluoride Containment Area Wet Floor Switch
   1) General: Used to detect a Fluoride tank leak.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives: None
   4) Monitoring:
      a) Local: None
      b) PCS: None
   5) Alarms:
      a) Local: None
      b) PCS: Fluoride Containment Area Wet Floor Switch Activated

14. HIGH SERVICE PUMPS
   a. High Service Pump 5
      1) General: Used to pump water into the water distribution system.
      2) Control:
         a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
         b) VFD: The VFD speed can be manually adjusted utilizing the manual speed potentiometer or VFD HIM module at the VFD.
         c) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of High Service Pump 5 via the HMI.
            (1) PC MANUAL: The operator shall have the ability to manually start/stop and adjust the speed of High Service Pump 5.
            (2) AUTO: High Service Pump 5 shall be automatically controlled via PLC programming. High Service Pump 5 shall be incorporated into the existing High Service Pump control scheme.
      3) Logic Interlocks/Permissives: None
      4) Monitoring:
         a) Local: Running, Stopped
         b) VFD: Running, Stopped, Frequency, Amps, Volts
         c) PCS: Remote, Running, Stopped, (2) Vibration Sensors, (2) Motor Bearing Temps, Frequency, Amps, Volts, VFD LOR Switch Position
      5) Alarms:
         a) Local: General Alarm
         b) VFD: VFD Fault Alarm
         c) PCS: Motor High Temperature, (2) High Vibration Alarms, (2) High Bearing Temp Alarm, Low Suction Pressure, High Discharge Pressure, VFD Fault, Loss of Signal

15. EXISTING PROCESS CONTROL MODIFICATIONS
   a. Groundwater Wells and Pretreatment Systems
      1) General: Used to pump water to the plant and provide treatment upstream of the NF Building Softening process.

2) Control: Modify groundwater pumps level control to be based on Break Tank levels instead of Clearwell levels.
   a) Operator shall have the ability to select Break Tank 1 or Break Tank 2 Level as control variable.

16. EMERGENCY POWER

a. Automatic Transfer Switch
   1) General: Used to automatically transfer plant power to generator during a utility power outage.
   2) Control:
      a) Local: Per manufacturer
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Generator running and Automatic Transfer Switch in the Emergency Source position will initiate step loading logic for loads to be sequentially started.
   4) Monitoring:
      a) Local: Per manufacturer
      b) PCS: Utility Source Available, Emergency Source Available, Utility Source Connected, Emergency Source Connected
   5) Alarms:
      a) Local: Per manufacturer
      b) PCS: Not in Auto

b. Generator
   1) General: Used to supply emergency power to the plant during a utility power outage.
   2) Control:
      a) Local: Per manufacturer
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Generator running and Automatic Transfer Switch in the Emergency Source position will initiate step loading logic for loads to be sequentially started.
   4) Monitoring:
      a) Local: Per manufacturer
      b) PCS: Running, Stopped, Remote
   5) Alarms:
      a) Local: Per manufacturer
      b) PCS: General Alarm, Not in Auto

17. CRITICAL ALARMS

a. General: Programming shall include the following as critical alarms. Critical alarms shall initiate a telephone call to designated personnel.
   1) Utility Power Failure
   2) PLC Failure Alarm
   3) Emergency NF Process Shutdown

3.2 EXAMINATION

A. Verification of Conditions: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Discrepancies: In the event any discrepancies are discovered, immediately notify the Owner's Representative in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 PREPARATION

A. Protection
   1. All equipment and materials shall be packed at the factory to protect each item from damage during shipment and storage.
   2. Provide blocking and cushioning materials to prevent damage during shipment.
   3. Panel mounted instruments and equipment to be installed inside enclosures, panels, or consoles shall be mounted and assembled at the panel manufacturer's facility.

3.4 INSTALLATION

A. General: Install equipment, as indicated, with manufacturer's written instructions and with recognized industry practices.

3.5 FIELD QUALITY CONTROL

A. Inspection: Provide for services of a qualified representative of the manufacturer to inspect and approve installation.

B. Tests: Upon completion of all inspections, and prior to acceptance, perform field tests outlined in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

C. Operational Demonstration: After completion of the field test, perform a 30-day operational demonstration as specified in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.6 DEMONSTRATION

A. General: When all required tests have been performed and prior to final acceptance, the Contractor shall perform a 30-day operational demonstration in accordance with the requirements of Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.7 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.

B. Quantity: Provide spares for each type of module listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
   1. Processor Modules
   2. Power Supply
   3. Digital Input Modules

4. Digital Output Modules
5. Analog Input Modules
6. RTD Analog Input Modules
7. Analog Output Modules
8. Analog Input/Analog Output Modules
9. Flex I/O Modules
10. Flex I/O Module Terminal Blocks

C. Provide (6) OIT protective screen overlays.

D. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no cost.

3.8 PLC SYSTEM TRAINING

A. General.
1. Provide a training course customized for the control system hardware.
2. Provide training on the operation and maintenance of the control system hardware.
3. Provide training manuals for each attendee plus two additional manuals in archival preservation at the project site.
4. Include the following in each manual.
   a. An agenda
   b. Defined objectives for each lesson.
5. Provide all equipment, materials, and supplies used in the training.
6. For guidance in planning the required instruction, assume that attendees will have a high school education or equivalent and basic electrical maintenance knowledge.

B. Location, duration, and schedule.
1. Teach the course at the project site.
2. Provide one day of training for five personnel designated by the Owner.
3. Conduct training after completion of the Contractor's field testing.

3.9 INPUT/OUTPUT SCHEDULE

A. Abbreviations
1. AI = Analog Input
2. AO = Analog Output
3. CPU = Processor
4. DI = Digital Input
5. DO = Digital Output
6. RTD = RTD Analog Input

B. Installed spare inputs and outputs (I/O): In addition to the I/O listed below, provide a minimum of 10 percent installed.
1. All SPARE I/O shall be wired to terminal blocks within the PLC enclosure.

END OF SECTION 40 9443

SECTION 40 9513

CONTROL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General:
   1. Drawings and general provisions of Contract.
   2. General and Supplementary Conditions and all Division 1 specification sections.

B. Related Sections of Division 26.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install control panels and consoles in accordance with the Plans and as specified herein.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of the National Electrical Code (NEC) and all other applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
   1. National Electrical Manufacturers Association (NEMA).
   2. Institute of Electrical and Electronic Engineers (IEEE).
   3. American National Standards Institute (ANSI).
   4. National Fire Protection Association (NFPA).
   5. Underwriters' Laboratories (UL).
   6. Joint Industrial Council (JIC).
   7. International Society for Measurement and Control (ISA).

C. Qualifications
   1. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of control panels whose products have been in satisfactory use in similar service for not less than 5 years.
   2. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with materials and equipment similar to items specified herein.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data for enclosures and all components.

B. Materials List: Submit a bill of materials listing quantities, manufacturer's name, and catalog numbers.

C. Wiring Diagrams: Submit wiring diagrams showing all connections for all equipment furnished or installed under this section.
   1. Elementary diagrams shall follow JIC standards.
   2. Instrument loop diagrams shall follow the ISA Standard S5.4.

3. Wire, terminal, and component labeling shall follow established facility conventions where applicable.

D. Shop Drawings: Provide control panel layout drawings which follow JIC standards. Provide shop drawings for each control panel and console as follows:
   1. Dimensional drawings of each enclosure and mounting panel.
   2. Scaled layout drawings identifying name and location of all components and nameplates.
   3. Mounting details including location of anchoring flanges, holes, and data on anchor bolt sizing and load-carrying capacity.
   4. Entry and exit locations of external wiring and conduit and equipment connections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: The Contractor shall store the items furnished under this section until they can be installed. Such storage shall meet the requirements of the manufacturer and be approved by the Owner. Use all means necessary to protect the material of this section before, during, and after installation, and to protect the installed work and materials of all other trades.

PART 2 - PRODUCTS

2.1 ENCLOSURES

A. Enclosure shall be NEMA 4X, unless otherwise specified or shown on the Drawings.
   1. Hinged Door Enclosures: Material of construction shall be fiberglass, 304 stainless steel or as shown on the Drawings.
      a. Manufacturer: Hoffman Enclosures, Inc.; Saginaw Control and Engineering; Stahlin Enclosures; or approved equal.
   2. Fabricated control panel shall be UL508A labeled.

2.2 COMPONENTS

A. As specified in related sections.

B. Miscellaneous Equipment
   1. Slotted plastic wiring ducts with snap-on covers.
   2. Nylon spiral wrap wiring sheaths.
   3. Nylon cable ties with screw anchors.
   4. Nameplates as specified in Division 26. Nomenclature as shown on the Drawings.
   5. Stainless steel screws, fasteners, and miscellaneous hardware, unless otherwise noted.

C. Corrosion Inhibitor Device: Shall be provided for all control enclosures. Provide one (1) unit per 5 cubic feet of volume. Provide one (1) replacement unit for each inhibitor device installed. Devices shall be Hoffman A-HCI 10E or approved equal. Install and date mark while enclosure is in fabricator's shop.

D. Provide thermostatically controlled electric heater in each enclosure for condensation prevention. Heater shall be sized for 40°F temperature rise above ambient, based on enclosure dimensions. Locate heater in compliance with manufacturer recommendations.

E. Surge Protection

1. Provide surge protection for all communication, analog and digital signals which the cable/conductor(s) enter from outside or underground. These signals include, but are not limited to, all 120VAC digital inputs and 24VDC analog inputs.
    a. Surge protection devices shall be type Category C as defined by IEEE C62.41, and consist of a base and a replaceable plug-in surge element.
2. Provide surge protection on all other PLC inputs, PLC outputs, relays and all other instrumentation and control system components as recommended by the manufacturer of each device.
3. Surge protection device shall include a visual indicator for "fault/no protection" indication.
4. Manufacturer: Pheonix Contact, Edco, Thor Systems or approved equal.

F. Power Supplies
1. Provide power supplies as required for the various components and functions of this contract.
2. Required Features:
    a. Provide power for 2-wire transmitter loops using 4-20mAdc current signals.
    b. Input Voltage: 115 VAC.
    c. Output Voltage: 24V to 45V DC, or 12V to 16V DC, as required.
    d. Voltage Regulation: $\pm$ 5 percent.
    e. Fusing: 115 VAC line.
    f. Loop circuits: Suitable for 1 loop circuit only.
    g. Mounting: Suitable for wall mounting inside of panel enclosure.
3. Manufacturers:
    a. Allen-Bradley Bulletin 1606.
    b. Moore Industries.
    c. Or approved equal.

G. Lighting Kit: Provide a 120VAC, fluorescent light fixture inside the enclosure. Fixture shall use 20 watt lamps, minimum. Each light shall include a manual on/off toggle switch and a 120VAC convenience outlet.

H. Uninterruptible Power Supply (UPS).
1. General: Provide a UPS to supply power to the control panel's associated PLC, radio, and internal power supplies during failure of normal power. Maintain battery power to load for 30 minute duration with "no breaks," or interruptions. Upon return of normal ac power, automatically equalize recharge batteries and revert to floating condition.
2. Enclosures: Free standing enclosures sized to house both the batteries and the electronics. DIN rail mounted units may be used when loads/battery time comply with specification requirements.
3. Rectifier/Charger: Solid state rectifiers/charger sized to supply dc power to both the batteries and the static inverter. Equip with automatic shutdown to prevent discharging the batteries completely.
4. Static Inverter: Single phase solid-state static inverter to supply regulated ac output.
5. Batteries: Sealed, maintenance-free lead acid batteries.
6. Detachable line cord and NEMA 5-20R output receptacles.
7. Available Manufacturers: Subject to compliance with requirements, manufacturers offering UPS systems which may be incorporated in the work include, but are not limited to, the following:
    a. APC
    b. Liebert

c. Pheonix Contact

I. Network Access Port
1. For enclosures that include a programmable logic controller (PLC), provide a door mounted GFCI 120VAC duplex power outlet, rated 3A minimum, with front door mounted RJ-45 Ethernet jack connected to the PLC network.
2. Provide a nameplate engraved with "For Programming Use Only".
3. NEMA 4X rated with hinged cover and securing latch
4. Power external outlet from a dedicated circuit breaker.
5. Provide CAT6 Ethernet cable internally from port to network switch.
6. Manufacturer:
   a. Grace Engineered Products, Inc
   b. Phoenix Contact
   c. Or approved equal

J. Miscellaneous Equipment
1. Slotted plastic wiring ducts with snap-on covers.
2. Nylon spiral wrap wiring sheaths.
3. Nylon cable ties with screw anchors.
4. Nameplates as specified in Division 26 Section "Electrical Identification", and as shown on the Plans.
5. Stainless steel screws, fasteners, and miscellaneous hardware unless otherwise noted.

2.3 SHOP FABRICATION

A. Fully assemble and test each panel at the factory prior to shipment.
1. Ensure that all wires and cables are securely connected.
2. Ensure all labels and nameplates are easily readable.
3. Perform 100% continuity checks.
4. Provide a temporary power source (120VAC), and check voltage on all applicable circuits, including all 24VDC power supplies.
5. Provide documents and drawings of the completed testing procedures.
6. Complete the fabrication and testing to the satisfaction of the Owner or its designee.
7. Factory Acceptance Test (FAT) – At the discretion of the Owner or its designee, fabricated panels may be subjected to inspection and testing prior to arrival at site. The FAT may be a prerequisite for acceptance. The Contractor shall plan for personnel to arrive at the fabricator's facility for the FAT. The Contractor shall also allow provisions for a Contractor's representative and a technician to assist in testing. Temporary power and networking should also be expected as part of the FAT procedure.
   a. A punch list shall be generated by the FAT personnel for any modifications needed prior to shipment to the Owner's facility. Successful completion of the FAT is a prerequisite for delivery to the Owner's facility. All FAT punch list items shall be resolved.

B. As a minimum, test all wiring circuits for conductivity and demonstrate that all specified functions can be performed.

C. Identify all components with laminated plastic nameplates.

D. Provide all devices, electrical hardware, wiring, support hardware, fasteners and other components required to make the control enclosures complete and workable units.

E. Estimated Size: Minimum sizes are shown on the Drawings. Contractor shall furnish enclosures of the size and quantity required to house the manufacturers' equipment supplied and all other electrical components installed in the enclosures.

F. Provide stainless steel quick-release latching clamps on three sides of each door and pad-lockable hasp and staple on all panels.

G. All hardware on the enclosures including hinges, pins, clamps, nuts, bolts, washers, screws, etc., shall be stainless steel.

H. Design panels so that conduits and wiring enter and leave through the bottom of the enclosures, unless noted otherwise.

I. Component Arrangement
   1. Group all like components.
   2. Place all internal components on sub-panels.
   3. Arrange all components to allow easy access for connections and service, and to allow removal without affecting other components.
   4. Provide a minimum of 2.5” from device terminals to edge of closest wiring duct.

J. Component Installation
   1. Make all panel cutouts carefully and leave no visible gaps between components and panels.
   2. Mount all components plumb and square.
   3. Attach all components and nameplates with stainless steel machine screws into drilled and tapped holes.
   4. Support and restrain all components to prevent movement.
   5. Attach all relays to mounting strips or rails.

K. Wiring
   1. Route wiring horizontally or vertically.
   2. Protect wiring to door-mounted devices with spiral nylon sheath.
   3. Separate alternating current (ac) and direct current (dc) wiring a minimum of 4 inches. Separate AC and DC buses.
   4. All DC (+) wiring shall be separately fused per device.
   5. Label all wires at each termination with a unique number.
   6. Label each terminal with a unique number.
   7. Terminate all external wiring on terminal blocks.
   8. Terminate all internal wiring on terminal blocks or device terminals. Device neutrals shall not be daisy-chained between devices.
   9. Group all externally powered wiring and terminate on knife disconnect isolating terminal blocks.
   10. Terminate all wiring to devices powered from the control panel on fused terminal blocks.
   11. Fused terminal blocks shall include LED blown fuse indication.
   12. Color code all internal wiring as follows:
      a. Line Voltage ac Power and Control: Black.
      b. AC Control Circuits: Red.
      c. DC Wiring: Blue (positive), Blue with White Stripe (negative).
      d. Externally Powered Wiring: Yellow.
      e. Neutral Conductors: White.
      f. Equipment Grounding Conductors: Green.

13. Route all wiring on sub-panels through plastic wiring ducts with removable covers. Wiring duct shall not be filled over 50%, including spares.
14. Support all wiring to prevent movement or sagging.
15. Secure all cable ties with bolted or screwed mounting plates.
16. Provide a warning sign, placed in a conspicuous location in the interior of the panel, identifying yellow wiring as being powered from an external source and warning that disconnecting power to the panel will not de-energize externally powered wiring.

L. Panel Grounding
1. Provide ground studs factory welded to the enclosure and the enclosure door.
2. Provide tinned copper braided ground strap between enclosure and door.
3. Provide a minimum #8 AWG ground wire from sub-panel to enclosure mounting stud.
4. Ground control power transformer secondary directly to sub-panel immediately adjacent to transformer.
5. Where signal cable shields are to be grounded in the control panel, connect to the equipment ground bus.
6. Connect all DC commons to the low-level isolated dc ground bus.

2.4 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.
1. Quantity: Provide spares for each type listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
a. Control Relay
b. Power Supply
c. Pilot Light
d. Selector Switch
e. Pushbutton
f. Fuses
g. Terminal Block
2. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no additional cost.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices.

B. Examination
1. Verification of Conditions: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Discrepancies: In the event any discrepancies are discovered, immediately notify the Owner's Representative in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

C. Preparation
1. Protection.

a. All equipment and materials shall be packed at the factory to protect each item from damage during shipment and storage.
b. Provide blocking and cushioning materials to prevent damage during shipment.
c. Provide temporary lifting lugs on shipping package as needed.
d. Include approximately 1 pint of touch-up paint for each finish color in shipment.

2. Surface Preparation: The work shall be carefully laid out in advance. Where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary, this work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved, and at no additional cost to the Owner.

D. Application

1. Enclosure, Cabinets, Console Installation.
   a. Locate as shown on the contract drawings. Freestanding enclosures and consoles require an Electrical Equipment Pad provided and installed by this Contractor. Refer to detail on Drawings.
   b. Floor-mounted control panels shall be installed utilizing all stainless steel hardware consisting of concrete anchor and machine bolt assembly.
   c. Wall-mounted panels shall be offset from walls with standoffs. Wall-mounted panels requiring freestanding mounting shall be supported on stainless steel strut with cross bracing and stainless steel hardware.
   d. Seal all conduit entrances watertight.

3.2 FIELD QUALITY CONTROL

A. Tests: Upon completion of all inspections and prior to acceptance by the Owner, perform the field tests outlined in Division 40 Section “Instrumentation – General”.

B. Inspection: Upon completion of this portion of the work, the Contractor shall provide for the services of a qualified representative of the manufacturer to inspect and approve the installation.

END OF SECTION 40 9513

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SECTION 40 9553

NETWORK DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General:
   1. Drawings and general provisions of Contract.
   2. General and Supplementary Conditions and all Division 1 specification sections.

B. Related Sections: Refer to Division 40 9XXX Sections for additional requirements related to this section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install network switches in accordance with the plans and as specified herein.

B. Types: The types of equipment specified in this section include the following.
   1. Ethernet Switch
   2. Ethernet Media Converter
   3. DIN-rail Fiber Patch Panel

1.3 DEFINITIONS

A. Abbreviations
   1. AHJ. Authority having jurisdiction.
   2. NRTL. Nationally recognized testing laboratory.

1.4 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information necessary to determine compliance with the Plans and specifications.

B. Product Data
   1. Manufacturer’s product data sheets, delete or cross out non-applicable information.

C. Quality Control Submittals
   1. Field test reports. Submit certified copies of the field test reports.
   2. Manufacturer’s instructions: Submit manufacturer's current installation instructions.

D. Contract Closeout Submittals: Operation and maintenance (O&M) data

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.
   3. All units of the same type shall be from the same manufacturer.

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 ETHERNET SWITCH

A. General: Provide an Ethernet switch for segment connection to the network backbone for area PLCs and operator workstations and as shown on the Drawings.

B. Features
   1. Minimum of (2) send/receive 100Base-FX fiber optic ports
   2. Minimum of (8) 10/100Base-TX (RJ-45) ports
   3. Per-port Status Indicators
      a. Link Integrity
      b. Disabled
      c. Activity
      d. Speed
      e. Half/Full Duplex
   4. Alarm Relay: 1A @ 30VDC
   5. Memory Card
   6. Management console port:
      a. Mini USB cable (driver provided)
   7. Power Requirements: 12-48VDC

C. Performance Requirements:
   1. Support spanning tree protocol
   2. Support ring topology
   3. Switch Management”
      a. Support Simple Network Management Protocol (SNMP)
      b. Bridging Management Information Base
      c. Remote Monitoring (RMON) control
   4. Comply to IEEE 802.3x Full-Duplex on 10Base-T and 100Base-T
   5. Full performance from 32 to 113°F, 5-95% humidity non-condensing

D. Small Form Factor Pluggable Module (SFP):
   1. SFP module shall be provided as integral part of the Ethernet switch to provide connection into fiber optic media as shown on the Drawings.
   2. Support for IEEE 802.3z, 1000BASE-SX standard for 1Gbps data transmission rate.

E. Product Manufacturer and Model
   1. Stratix 5700 Switch, 1783-BMS10CL or equivalent latest compatible series, as manufactured by Allen-Bradley

2.3 ETHERNET MEDIA CONVERTER

A. Description: Converts 10/100Base-T(X) Ethernet media from copper to fiber optic.

B. Features
1. Converts to utilized fiber optic cable type as indicated on the Drawings.
2. (1) 10/100MBit/s RJ45 Port
3. (1) 100MBit/s SC-FX Port
4. Fiber wavelength shall be 1300nm
5. Auto-negotiation
6. Integrated MDI/MDIx changeover
7. Status and diagnostic indicators on device
8. Redundant power supply capable
9. DIN rail mounted
10. Conforms to IEEE 802.3
11. Input power: 24VDC
12. Operating Temperature Range: 32degF – 131degF
13. Humidity: 30-95%, non-condensing

C. Manufacturers: Subject to compliance, provide products manufactured by one of the following:
1. Phoenix Contact
2. Hirschmann
3. Or approved equal.

2.4 DIN-RAIL FIBER PATCH PANEL

A. General: Shall be designed to manage and organize fiber optic cables to and from the equipment or cabling plant.
1. Single panel housing fiber optic enclosure adapted for DIN-rail mounting
2. Protect fiber optic connections for patching or splicing requirements
3. Accommodate up to 12 fibers per enclosure and shall be constructed of steel
4. Include removable covers and pass-through holes
5. Model and Manufacturer:
a. SPH-01P, enclosure by Corning
b. CCH-CP12-15T, adapter plate by Corning

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Conform to manufacturer recommended installation guidelines.
2. Mount the Ethernet switches in enclosures indicated on the Drawings.

B. Physical Network Architecture
1. Physically configure the plant-wide LAN system as shown on the Drawings.
2. Some workstations will be equipped with two network interface cards (NIC) for connection to both networks.
3. IP addresses shall be assigned by Owner for all equipment connected to the plant networks.

3.2 FIELD QUALITY CONTROL

A. Field Test
1. Conduct testing after all connections are made.

2. Test the switches for proper operation by simulating fault conditions at the input terminals of the LAN equipment.
3. Correct any malfunction or error in the designed performance.
4. Check the operation after all LAN equipment has been wired by manually activating the inputs with testing devices that simulate network traffic.

B. Manufacturer Field Services
1. Provide the services of a factory-trained manufacturer representative to configure and start-up equipment specified under this Section.
2. Certify in writing that that the equipment has been installed, configured, and tested in accordance with manufacturer recommendations.

3.3 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.
1. Quantity: Provide spares for each type listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
a. Ethernet Switch
b. Ethernet Media Converter
c. DIN-rail Fiber Patch Panel
2. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no additional cost.

END OF SECTION 40 9553

SECTION 46 6340

NANOFILTRATION MEMBRANE EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. OEM and Contractor Scope
   1. The OEM's scope shall include all work after the inlet flange connection on the skid and shall end at the flanged connections for the permeate, concentrate, and cleaning connections after the various control, isolation, and block and bleed valves. NF feed pumps will be provided by Contractor (off-skid).

B. The system provided under this specification shall be complete and operable in all respects including, but not limited to connections to other systems and facilities, component and system tests, calibration, alignment, and adjustments as necessary to place the system in operation to perform its intended function.

C. The Contractor shall coordinate scheduling, delivery, and shall unload, store, protect equipment, and install the equipment.

D. Connections of electrical, control, and instrumentation components shall be furnished and installed as specified in Division 26 and 409XXX.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Division 09, Section "High Performance Coatings."

B. Division 26—Electrical.

C. Division 40—Process Integration.

1.4 QUALITY ASSURANCE

A. The skid components shall be manufactured from all new materials and equipment.

B. The Owner and/or Engineer shall be provided access at any time to inspect or observe all equipment prior to shipment to the site.

C. All valves, actuators, flow meters, and instrumentation shall be of the same type and from the same manufacturer.

1.5 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 General Requirements.

B. Manufacturer shall submit P&IDs for all equipment furnished under this section to the Engineer for approval, prior to submittal of shop drawings. Once P&IDs have been approved, Manufacturer shall submit shop drawings to the Engineer for approval, in accordance with the Contract Documents, for equipment furnished under this section.

C. Manufacturer's product data including but not limited to valves pressure vessels, end assembly, piping, couplings, membrane elements, instrumentation, controls, and electrical components. Data sheets shall include materials of construction for all hardware used to assemble the skids.

D. Submit process design information detailing the number of stages, number of pressure vessels per stage, flux rate per stage and for the entire membrane train, design feed pressures, design product water quality parameters (based on the projected feed water quality), number of membrane elements per pressure vessel, general information on the proposed membrane element, specific instructions on membrane train construction based on membrane system configuration, piping plan and sections, wiring plan, wiring diagram, control panel layout, sample panel layout, and other relevant information.

E. Assembly and installation drawings including arrangement, layout, and dimensions of all components of the membrane trains, including the control panel, sample panel, piping connections and membrane element loading sequence.

F. Factory acceptance testing results.

G. The OEM's printed instructions for the handling, delivery, storage, and installation of the membrane system components.

H. Operations and Maintenance (O&M) Manual
   1. The OEM shall prepare a comprehensive operation and maintenance (O&M) manual for the system specified as part of this Contract. The manual shall include information on the operation and maintenance of the individual components of the system, and on the operation of the overall package. O&M Manual shall be in accordance with Division 01, Section "Operation and Maintenance Data".

I. The OEM shall also provide personnel training prior to startup, and field assistance during the system checkout, startup, and commissioning.

1.6 SPARE PARTS

A. Provide two spare grooved-end, flexible-type coupling assemblies for each size and type supplied on the membrane skid assembly.

B. Provide two pressure vessel repair kits, consisting of all O-rings and seals and clips required for the rebuilding of one end closure assembly.

C. Provide four permeate orifice plugs, sized to simulate hydraulic design of the membranes.

1.7 HANDLING, DELIVERY, AND STORAGE

A. The OEM shall fabricate and deliver all components of the NF System to the site.

B. All components shall be properly crated and stored at the job site until ready for installation. All components shall be kept clean, dry, and protected from freezing.

C. Weight, handling instructions, type of storage required, and instructions for protective maintenance during storage shall be included with each shipment to the job site.

1.8 WARRANTY

A. The membrane manufacturer shall guarantee the membrane performance as specified herein during the performance warranty period as described below:
   1. Performance Warranty Period: 1 year full warranty plus 2 additional year warranty pro-rated.

B. If the performance requirements specified (permeate water quality and feed pressure) are not met the OEM shall replace all membranes at no cost to the Owner until the requirements are met.

C. Performance Requirements:
   1. Performance Requirements are included in the NF Membrane Equipment Schedule.

PART 2 - PRODUCTS

2.1 GENERAL

A. NF Skid design information and dimensions are included the NF Membrane Equipment Schedule.

B. Membranes
   1. Provide interconnectors, O-rings, and brine seals required for installation in specified pressure vessels. Elements shall be non-telescoping, non-flexing, and leak-free.
   2. Spiral Wound Thin-Film Composite.
   3. Nominal Diameter: 8 inches.
   4. Nominal Length: 40 inches.
   5. Nominal Active Membrane Area: 400 square feet.
   6. Seal Materials: Brine seals and O-rings shall be manufactured from EPDM.
   7. Feed Brine Spacer Thickness: 34 mil.
   8. Manufacturer/Model:
      a. DOW/NF90.

C. Manufacturers
   1. Wigen Water Technologies
   2. H2O Innovation
   3. Harn

2.2 SKID ASSEMBLY

A. Material
   1. Base Bid: Epoxy Coated Carbon Steel or FRP
   2. Alternate Bid: 304 SST

B. Frame/Supports
   1. Fabricate frame and supports using material as noted above.
   2. If onsite erection or assembly of the frames is required, OEM shall certify that the skids have been constructed correctly.
   3. All other supports and hardware on the skids shall be either 304 SST or FRP.
   4. Frames shall be designed and stamped by registered professional engineer, and all calculations submitted in accordance with Division 1 Section “Submittals”.

C. Anchor Bolts
   1. Contractor shall provide 316 SST expansion bolts to anchor the skid to the equipment pad below. OEM to coordinate with Drawings to determine anchor bolt locations.

D. Accessories
   1. Locate control panel, sample panel, pressure transmitters, flow transmitters, conductivity meters, and other instruments for each skid where indicated on the drawings, and no less than 2.5 feet no more than 5 feet above floor level.

2.3 FEED, INTERSTAGE, CONCENTRATE, AND PERMEATE PIPING

A. All high pressure feed, interstate, and concentrate piping shall be 316 stainless steel, schedule 10S conforming to the requirements of Division 40, Section “Process Piping.”
   1. All stainless steel piping associated with the membrane skid shall be stress relieved and passivated. Passivation shall be continued to a bright metal finish.
   2. All stainless steel piping shall be thoroughly cleaned inside and out, disinfected, and all scale and welding slag removed.
   3. All piping shall be designed for a working pressure no less than the shutoff head of the NF Feed Pumps being provided (OEM to coordinate with Contractor and NF Feed Pump Supplier).
   4. All stainless steel spool pieces shall be pressure tested to 1.5 times the rated working pressure of the pipe. Pressure testing shall conform to the requirements set forth in Division 40 Section “Process Piping”. Cut or roll-groove as appropriate to the pipe material, wall thickness, pressure, size, and method of joining. Use Victaulic “RX” rolls for grooving Schedule 10 stainless steel pipe.

B. All other piping shall be Schedule 80 PVC conforming to the requirements of Division 40, Section “Process Piping.”

C. Vessel Connections
   1. Feed, Interstage, and Concentrate Connections: Side-ported pressure vessels shall be directly connected to their respective manifolds using grooved-end flexible pipe couplings.

D. Grooved-End Flexible Pipe Couplings
   1. Housings: 304 SST
   2. Gaskets: EPDM rubber, suitable for hot and cold water service.
   3. Bolts / nuts: Round head, square neck, type 316 SST bolts and heavy hex type 316 SST nuts. Washers shall be heavy pattern 316 SST.
   4. Pressure Rating
      a. < 2-inches: 600 psi.
      b. 2-inches and larger: 300 psi.
   5. Manufacturer: Victaulic Style 489, Piedmont Style K, or Engineer Approved Equal.

a. All grooved components shall be of one manufacturer. Installation shall be in strict accordance with the coupling manufacturer's latest published instructions.

E. OEM shall carefully review drawings for coordination on skid connection locations. Skid connection locations have been located for coordination with the Architectural and Structural Layout of the Building. Alternate connection points may not be acceptable. No additional costs will be paid by the Owner for piping revisions that are required for alternate connection points.

F. Manifolds and piping shall be securely supported from the vessel support structure. Manifold support stanchions that are welded to the manifold must be the same material and finish as the manifold. For side-ported pressure vessels, provision must be made for either the feed or concentrate manifold of each stage to allow for movement of the manifold with the vessel side ports as vessel length expands under pressure. Manifolds shall not rely upon mechanical-type coupling joints to support coupled sections of manifolds.

2.4 SIDE PORTED PRESSURE VESSELS

A. Pressure vessels shall be as specified in Division 46 Section "Side Ported Pressure Vessels".

2.5 VALVES

A. Valves and actuators shall conform to the requirements of Division 40 Section "Process Valves, Gates and, Accessories."

2.6 INSTRUMENTATION

A. Flow Measurement
   1. Magnetic Flowmeters
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments."
   2. Paddlewheel Flowmeter
      a. Manufacturer/Model: Seametrics IP800 Series or Engineer Approved Equal.
      b. Materials: Cast Aluminum housing, PVC sensor, Viton O-ring, PVDF rotor, and Kynar shaft.
      c. Features: 4-20 mA output, loop powered.

B. Pressure Measurement
   1. Pressure Transmitters and Switches
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   2. Pressure Switches
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   3. Pressure Gauges
      a. In accordance with Division 40, Section "Process Valves, Gates, & Accessories".

C. Analyzers
   1. ORP
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   2. Conductivity
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   3. Temperature
      a. Moore Industries TDZ with D2LC housing or Engineer Approved Equal.

2.7 SAMPLE PANEL

A. There shall be a sample panel on each skid made of HDPE or FRP. The panel shall be mounted with corrosion resistant clamps (316 SST) similar to those used to attach the pressure vessels to the support structure.

B. The sample panel shall be fitted with angle-pattern, 1/4-inch-turn, black PVC valves, installed to panel with Swagelock backhead tube fitting SS-400-71-4 for 1/4-inch OD tubing or Engineer Approved Equal.

1. There shall be one sample valve for the permeate for each pressure vessel on the skid, plus valves for 1st stage feed, interstage, concentrate, 1st stage total permeate, 2nd stage total permeate, and total permeate. Provide a label for each sample valve corresponding to the location from which the sample is drawn.

C. The sample panel shall be equipped with a 6-inch deep x 6-inch wide trough for each row of sample valves, of the same material as the panel, which shall be drained by a 2-inch PVC pipe. Route drain pipe to trench drain located beneath each skid as shown on the drawings. Provide slope in trough to properly drain sample water. Provide adequate clearance for a one-gallon milk jug between the sample valves and the trough.

D. Sample tubing shall be 1/4-inch OD polyethylene, with a minimum working pressure of 300 psi at 75 deg F. Sample tubing shall be black. Tubing shall be Manufactured by Imperial Eastman Division, Imperial Clevite, Inc., or Engineer Approved Equal.

E. Tubing shall be neatly arranged and bundled where possible. Bundles shall be retained with nylon tywraps, or grouped in PVC conduit with properly arranged openings for tubing. Label sample taps according to stage and sequential number.

2.8 WET PANEL

A. A Wet Panel shall be provided for each skid made of HDPE or FRP board, floor-mounted where indicated by the Drawings, adjacent to each skid. The panel shall be mounted on FRP supports with corrosion resistant (316 SST) clamps similar to those used to attach the pressure vessels to the support structure. The Skid Wet Panel may be combined with the Skid Sample Panel.

B. The Wet Panel shall incorporate all instrumentation and control components local to each train except for those that must be installed inline, or otherwise indicated in the PID drawings. The panel shall include pressure gauges, transmitters, indicators, analytical instruments, and other components indicated on the Drawings. The panel shall consist of a flat panel for gauges, analytical sensor cells, and other surface mounted components; a NEMA 4X enclosure for mounting analytical transmitters, electronic displays, and components.

C. Skid shall include drain piping from the wet panel to the trench drain beneath each skid as shown on the drawings.

2.9 MCS SYSTEM

A. MCS Tanks(s)

1. MCS Tank(s) are specified in Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances". These tanks to be provided by the Contractor. OEM to coordinate with Contractor and MCS Tank Supplier.

B. Piping
1. MCS Piping is specified in Division 40 Section "Process Piping". MCS piping shall be provided and assembled by the Contractor. Skidded MCS systems are not acceptable.

C. Valves
1. MCS valves are specified in Division 40, Section "Process Valves, Gates, and Accessories". MCS valves shall be provided by the Contractor. OEM to coordinate with Contractor and MCS Valve Supplier.

D. Pump(s)
1. MCS Pump(s) are specified in Division 43, Section "Horizontal End Suction Pumps". These pumps shall be provided by the Contractor. OEM to coordinate with Contractor and MCS Pump Supplier.

E. Cartridge Filter Housing(s)
1. MCS Cartridge Filter Housing(s) are specified in Division 44, Section "Cartridge Filters and Appurtenances". Cartridge filter housing(s) shall be supplied by the Contractor. OEM to coordinate with Contractor and Cartridge Filter Housing Supplier.

F. Instrumentation/Accessories
1. MCS System instrumentation and accessories shall be provided by the OEM. OEM to coordinate with Contractor and Instrumentation Supplier. Conduit and wiring between instrumentation and MCS shall be provided by OEM. Conduit and wiring shall comply with Division 26 and 409XXX series specifications.

G. Water Heaters:
1. OEM shall provide the heaters. OEM to coordinate with MCS Tank Supplier.
2. Sizes: Per the equipment schedule.
3. Material: 304 SST flange and Incoloy sheath.
4. Electrical Characteristics: 480V, 3 phase, cold section first 10 inches. Include thermostat.
5. The heater shall have a maximum temperature thermostat switch to prevent excessive heating and damage to the tank.
6. Installation: Per the manufacturer's recommendations.
7. Manufacturer: Indeeco, Chromalox, or Engineer Approved Equal.

2.10 PERMEATE FLUSH SYSTEM

A. Permeate Flush System (PFS): OEM shall provide the permeate flush system (where indicated) which shall include tank(s), pump(s), valves, meters, and controls as indicated on the drawings.

B. Permeate Flush Tanks(s)
1. Permeate Flush Tank(s) are specified in Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances". These tanks to be provided by the Contractor. OEM to coordinate with Contractor and Permeate Flush Tank Supplier.

C. Piping

1. Permeate Flush Piping is specified in Division 40 Section “Process Piping”. MCS piping shall be provided and assembled by the Contractor. Skidded Permeate Flush systems are not acceptable.

D. Valves
1. Permeate Flush valves are specified in Division 40, Section “Process Valves, Gates, and Accessories”. Permeate Flush valves shall be provided by the Contractor. OEM to coordinate with Permeate Flush Valve Supplier.

E. Pump(s)
1. Permeate Flush Pump(s) are specified in Division 43, Section “Horizontal End Suction Pumps”. These pumps shall be provided by the Contractor.

F. Instrumentation/Accessories
1. Permeate Flush System instrumentation and accessories shall be provided by the OEM.

2.11 ACCESSORIES

A. SDI Test Apparatus
1. Provide and install one silt density index (SDI) test apparatus for each array at the sample panel.
2. SDI test apparatus shall conform to the requirements of ASTM D4189.
3. Provide 500 filters with each apparatus.

2.12 IDENTIFICATION

A. Identify all equipment per Division 40 Section “Process Valves, Gates, and Accessories”.

B. Identification Schedule
1. Identify all valves on each skid. Valve numbers are listed in the valve schedule.
2. Identify all piping using the language indicated on the drawings.
3. For cleaning connections, provide placards mounted on the piping showing and describing the valve settings for cleaning both stages.
4. Identify each pressure vessel. Locate the label on the side of the pressure vessel facing the sample sink and at the front of the skid. Pressure vessel numbering shall correspond to the sample valve numbering.
5. Identify each pressure gauge, transmitter, flow element, analytical element, and all other pieces of equipment. Tag shall be descriptive of the equipment, i.e. “1ST STAGE FEED PRESSURE”.

2.13 ELECTRICAL

A. Refer to Division 26 - Electrical for Electrical Requirements.

B. Conduit
1. All on skid electrical and control conduits shall be schedule 80 PVC conduit in accordance with Division 26, Section “Raceway.”

2.14 CONTROL PANELS

A. OEM shall provide the following control panels:

1. NF Skids Master Control Panel (NF-MCP)
2. NF Skid Control Panels (NF1, NF2, NF3, etc….)
3. NF MCS Control Panel (MCS-CP)

B. Control Panels and components shall be in accordance with Division 40, Section 409XXX series and as shown on the drawings.

C. MCS Control Panel (NF-MCSCP)
1. Provide VFDs for each MCS Pump (MCSP-1 and MCSP-2) and Permeate Flush Pump (PFP-1).
   a. VFDs shall be in accordance with Division 26, Section "Variable Frequency Drives".
2. Provide local on/off switches for operation of the heaters.

D. Provide spare parts for control panel components as specified in Section 409XXX series.

2.15 CONTROLS

A. Provide controls for all elements scope supplied. All instrumentation required to control and monitor the operation of the equipment shall be provided including all PLC and OIT programming for all supplied equipment.

B. OEM shall control the NF Feed Pumps (NFFPs).
1. There will be one (1) feed pump for each NF skid.
2. NF feed pumps are VFD driven.
3. NF-MCP shall control the VFD to slowly adjust the pump flow rate to desired setpoint.

C. Provide an electronic copy of the software on a USB jump drive to allow the customer to reconfigure the program. The software provided to the customer shall be the "As-Built" version of the operating program that includes all start up and on-site changes that were made to the original program.

D. Control components, where specified within this section, shall be provided under this section.

E. The equipment specified under this section shall operate manually/automatically as shown on the drawings and specified in Section 409XXX. Any additional materials of equipment required by this section's OEM, but not shown on the drawings or specified in sections 409XXX, to allow this equipment to function in the required manner, shall be furnished and installed under this section.

F. Provide all miscellaneous supports, brackets, fasteners, and fabrications required to mount and install equipment controls provided under this section.

2.16 NF CONTROL DESCRIPTION

A. The controls shall be designed to operate and control the NF Skids, NFFPs, MCS system, and Permeate Flush System.

B. The permeate flux and recovery shall be adjustable such that the skid can be programmed to make different amounts of permeate. OEM shall program the skids to operate at varying capacities by adjusting the permeate flux and recovery.

C. NF Flow Calculations
   1. Operator shall have the ability to enter the desired NF flux rate (gfd) and percent recovery (%) for each NF skid.
   2. Operator shall have the ability to enter the number of pressure vessels in the first stage (#PV1) and second stage (#PV2), number of elements per vessel (#EL), and square footage of membrane area per element (AEL) for each NF Skid. #EL and AEL shall be a common input at one location for all skids.
   3. Indicate the Total #PV (#PV1 + #PV2).
   4. Indicate NF Permeate Flow (NFP = #PV x AEL x Flux)
   5. Indicate NF Feed Flow (NFF = NFP / % recovery)
   6. Indicate NF Concentrate Flow (NFC = NFF – NFP)
   7. Indicate 2nd Stage NF Concentrate flow per pressure vessel:
      a. NFCPV2nd = NFC / #PV2nd
      b. If NFCPV2nd < 15, then provide alarm stating “Minimum 2nd Stage NFC flow per Pressure Vessel too low. Lower % recovery or raise flux.”

D. Communicate all parameters with the Plant SCADA system (PCS). Refer to Division 40, Section “Plant Control System” for a description of the plant operation.

E. General
   1. The following control function description is preliminary; final design, detailing, and implementation of control strategy will be performed by the OEM.
   2. All skids will be controlled by NF-MCP which will receive run/shutdown signals from the NF Building ACP (NF-ACP). NF-MCP will also receive the number of NF skids to be in service. Interface with NF-ACP must be coordinated with the System Integrator.
   3. All control functions on the skids shall have Local Automatic, Remote Automatic, Off, and manual override. Manual control shall be limited to authorized personnel only and shall not be selectable from the face of the control panel. Remote/local selection shall apply to the overall start and stop function only, and shall not interfere with manual/auto operation of individual components, except where necessary safeties apply.
      a. Remote position of selector permits the skid to receive the plant run signal from the NF-ACP.
      b. Local position of selector inhibits the skid from receiving the plant run signal from the PCS.
      c. All NF skid components must be capable of manual operation, but manual controls shall not be located individually at the NF Skid Control Panel (NF1, NF2, NF3, etc…)

F. Start Sequence
   1. Start signal will be sent from the NF-ACP to NF-MCP. The number of NF skids in service will be sent from the NF-MCP to NF-ACP. Only one skid shall start at a time. Only one skid shall shutdown at a time (except for alarm conditions).
   2. Pre-Flush
      a. Open the NF concentrate (NFC) throttling valve 100%.
      b. Close NF permeate (NFP) valve and open NF permeate dump (NFD) valve.
      c. Start the NF feed pump at 25% and increase speed to obtain pre-programmed concentrate flow rate.
      d. At the end of the pre-flush period, open the NF permeate (NFP) valve and close the NF permeate dump (NFD) valve. Valves shall be programmed to open/close slowly over 1 minute). Turn control over to the PID loops.
      e. If pre-flush continues beyond an operator adjustable duration, initiate alarm.

G. Permeate Flush System (if equipped)
   1. Permeate Flush system shall be operated as described below during permeate flushing:
      a. Permeate Flush tank fill shall be automatically controlled. Tank fill shall be accomplished using the Permeate Flush Tank fill valve, and the Permeate Flush Tank tank level sensor. The Permeate Flush System tank level sensor shall include operator adjustable setpoints for pump cut off, low water level, fill, and high water level.
      b. Flush shall be performed as described under normal shutdown sequence. NF PLC to control all valving on the skid being flushed as well as the Permeate Flush Pump on/off and speed.

H. MCS System
   1. MCS system shall be operated as described below during membrane cleaning:
      a. Skid to be cleaned shall be locked out from running via a HMI selector switch on any of the OITs. All automatic valves on the skid shall be automatically placed in the appropriate position for cleaning.
      b. MCS tank fill will be manually controlled.
      c. MCS tank water shall be automatically heated. Heating shall be accomplished using the heater. An operator adjustable setpoint shall be used to set the desired heated water temperature. An operator adjustable setpoint shall be included for a high temperature alarm. Heating is initiated using an operator controlled on/off/auto switch.
      d. Once the MCS tank water is heated, the operator will manually add chemical (either in the top of the tank or using the eductor) and manually start the MCS pump using the on/off/auto switch. Operator will manually throttle the flow by observing the flowrate and controlling the VFD speed on the MCS pump.

I. Normal Run Operation
   1. Start the selected skid (one at a time). NF-MCP shall automatically rotate the skids and shall display the accumulated skid runtime. If any skid has not ran for an operator selectable duration, provide an alarm indicating that the skids have to be rotated.
   2. The operator shall be able to exclude each skid from running using a selector switch on any of the OITs. Each skid shall be started at 50% of design capacity and ran for 60 seconds before increasing slowly to the desired flow rate setting.
   3. Permeate Flow Control: The feed flow meter controls the feed pump VFD to maintain the preset flowrate.
   4. Concentrate Flow Control: Concentrate flowmeter controls the concentrate control valve to maintain the pre-set concentrate flow rate.
   5. Flow rates, pressures, and conductivities shall be monitored by the NF skid system controller. If any parameter goes beyond pre-set limits for more than an allowable time, it will indicate on the control panel and send a general alarm to the plant control system.
   6. If ORP exceeds setpoint, shut down the skid.

J. Normal Shutdown
   1. Stop signal will be sent from the NF-ACP to NF-MCP. The number of NF skids in service will be sent from the NF-MCP to NF-ACP. Only one skid shall stop at a time.
   2. Post-flush
      a. System shall be set up for flushing with feed water (forward flush) or Permeate Flush (if equipped). If equipped, an operator adjustable selector switch shall indicate which flushing water source is to be used (forward flush or permeate flush).

b. Control the NF feed pump or the permeate flush pump and/or the NF concentrate (NFC) control valve speed to obtain operator adjustable concentrate flow rate during the flush.
c. Open NF permeate dump (NFD) valve and close NF permeate (NFP) valve.
d. Open NF concentrate (NFC) valve 100%.
e. Continue post-flush for an operator adjustable setpoint duration.
f. Stop the NF feed pump or the Permeate Flush Pump.
g. Close the NF feed valve.

K. Emergency Shutdown (Loss of Power): The emergency shutdown sequence shall be identical to the normal shutdown except that it is initiated by the shutdown logic rather than the operator.
1. All skids stop.
2. NFC valve fails open.
3. NFD valve fails open.
4. No automatic restart of feed pumps or skids.

L. Alarms and Shutdown (Internal Logic): There are a variety of conditions listed below which must be verified prior to proceeding with the next step in a start-up or shutdown sequence. These will be defined by the Engineer in conjunction with the OEM following contract award. Should any of these conditions be detected, the NF-MCP PLC shall issue an alarm indicating the failing equipment or permissive that caused the fault, and halt the sequence. If in automatic sequencing, the PLC shall shutdown the skid. If in manual sequencing, the PLC shall either proceed or shutdown the skid as directed by the operator via the OIT. The discrepancy alarm shall describe the condition which caused it in sufficient detail for the operator to investigate and correct the problem.
1. pH out of range: Alarm in main control system.
2. NF feed suction low pressure: alarm and skid shutdown with post-flush.
3. Antiscalant low tank level: Alarm and normal plant shutdown (in main control system).
4. Antiscalant no flow: Alarm and normal plant shutdown (in main control system).
5. High permeate pressure on each skid: Shut down skid with post-flush.
6. Cartridge filter high differential pressure: Alarm in main control system.
7. NF Feed pump high pressure: Alarm and shut down with post-flush.
8. Failure of valve to reach specified position: Alarm.
9. High permeate conductivity: Alarm.
10. Permeate valve and permeate dump valve both closed: Shutdown with post-flush.
11. Concentrate valve closed: Shutdown, no post-flush.
12. Low concentrate flow: Shutdown with post-flush.
13. NF skid rotation: Alarm.

M. Include a performance monitoring software system for purposes of:
1. Automatic data acquisition
2. Data trending
3. Report generation
4. Alarm management including notification and alarm archiving
5. Remote web access to view data trending and reports
6. Facilitating system performance analysis
7. Facilitating performance optimization
8. Refer to Part 3 “Service Agreement and Remote Monitoring”

PART 3 - EXECUTION

3.1 INSTALLATION OF MEMBRANE ELEMENTS

A. Conform to the requirements of Division 01, Section “Quality Control”, paragraph 1.8, Manufacturer's Field Services.

B. Installation work shall conform to the Membrane Manufacturer’s recommended procedures, instructions, and approved loading sequence.

C. Provide for the services of a factory trained service technician of the membrane manufacturer to be present to supervise the installation of the membranes.

3.2 FACTORY ACCEPTANCE TESTING

A. After final assembly is complete and prior to being shipped, each fully assembled skid shall undergo factor acceptance testing. All piping, pressure vessels, and associated appurtenances shall be testing to 150% of their maximum operating pressures. Any leaks, if discovered, shall be repaired, and factory acceptance testing shall be redone. OEM shall submit results of factory acceptance testing for approval. If desired by the Owner and/or Engineer, factory acceptance testing will be witnessed, in-person. OEM shall give written notice to Engineer no less than thirty (30) days prior to factory acceptance testing. OEM is not responsible for travel, lodging, or meal costs for the Owner or Engineer.

3.3 SPECIAL SERVICES

A. Conform to the requirements of Division 01, Section “Quality Control”, paragraph 1.8, Manufacturer's Field Services.

B. Follow the manufacturer's recommended procedures for testing, adjusting, and placing of equipment into proper operation.

C. Startup and Commissioning
   1. Functional Testing
      a. Functional testing of the membrane system shall be accomplished for each membrane skid with test orifices installed in the permeate ports of each vessel to simulate pressure drops. Skid to be operated at representative flows with automatic instrument control as required to confirm responsiveness over design operating range. Testing shall continue until each skid can be run for four consecutive hours without interruption. Two successful start-up and shutdown sequences shall be demonstrated prior to the start of the four-hour test. Demonstration of correct control loop operation in conjunction with CPI loop testing is also required.
      b. At the conclusion of the functional testing the vessels shall be disinfected, cleaned with a manufacturers recommended detergent, and flushed to ensure vessel cleanliness. Vessel interior surfaces shall be thoroughly wiped prior to the loading of the membranes. During membrane loading the brine seals, O-rings, connectors, anti-telescoping devices, and physical condition of the module wrap shall be inspected. Serial numbers and pressure vessel location of each membrane element shall be documented, tabulated and provided to the Engineer for review.
   2. Start-up Testing: Each membrane skid shall be started up, one at a time, and operated for a total of eight hours over a two-day period at design conditions. During this time two bacteriological samples (permeate) shall be taken and tested for heterotrophic plate count

(HPC). Acceptance shall be based upon bacteriological testing of permeate samples showing HPC less than 500 colony forming units per milliliter (CFU/ml). All samples shall be analyzed by an Ohio EPA certified laboratory.

3. Performance Testing
   a. Time of Performance Testing: The performance testing for the membrane system shall occur following completion of all facilities and equipment required for the testing. Final acceptance of the membrane system will be contingent upon successful performance testing. Performance testing of each train must be initiated within 60 days of bacteriological testing during startup.
   b. Testing Protocol: The OEM shall submit a proposed testing protocol 60 days prior to the initiation of the membrane system performance testing. The testing protocol shall have written approval by the Engineer prior to commencement of the testing program. The testing protocol shall include, but not be limited to, water quality sampling parameters, sampling locations, projected dates of the performance testing, Ohio EPA approved laboratory to be used for the water sample analysis, and time of sampling relative to time zero. Time zero for the membrane system performance testing is the time of the first sample.
   c. Duration of Performance Test: Each membrane skid shall be tested for four (4) consecutive days. Two (2) skids may be tested at a time. The OEM shall be fully responsible for every aspect of the performance test. Representatives of the OEM and shall be on site during the entire performance test. Representatives of the Engineer and Owner may also be present during the performance test.
   d. Performance Test Conditions: Each membrane skid shall be tested under design operating conditions.
   e. Data Collection During Performance Test: The following continuous data shall be collected hourly unless otherwise specified during the performance testing:
      1) Water Quality: feed water temperature, feed water conductivity, feed water pH, permeate temperature, permeate conductivity, permeate pH, concentrate conductivity, feed water SDI (twice daily), feed water turbidity, concentrate pH. Temperature, pH, and turbidity readings may be taken from the plant instrumentation provided the instrumentation is operable and calibrated at the time of the test.
      2) A Heterotrophic Plate Count sample shall be taken from the raw water, feed water, interstage feed, concentrate, and permeate within 4 hours after initial startup for each train and repeated just prior to the completion of the performance test. Samples and cultures of samples shall be in accordance with AWWA Standard Methods, current edition.
      3) Mechanical Data: feed water pressure, interstage pressure, permeate pressure, permeate flow, concentrate flow, flow control valve position, concentrate valve position, wells, operating, startup and shutdown times, chemical flow rates and dosages.
   f. Discrete Water Sampling: Samples shall be once per day during the four-day testing for a total of 4 sampling events. During a sampling event, the OEM shall take discrete water samples from the skid's feed, permeate, and concentrate streams for calcium, magnesium, total hardness, sodium, potassium, iron, manganese, barium, strontium, alkalinity, chlorides, sulfates, sulfides, nitrates, nitrites, fluoride, silica, pH, and total dissolved solids. The OEM shall submit samples to an Ohio EPA approved laboratory for analysis. All analytical results shall be transmitted to the OEM and Engineer.
   g. Test Report: A formal bound report shall be produced and submitted to the Engineer for all testing activities. Report shall contain detailed test plans and

results for all activities performed during testing. Results from all testing shall be tabulated, trended, and graphed as appropriate. Discussion of testing, along with conclusions and recommendations, shall be presented in the test report. All laboratory analyses shall be bound into the report as appendices.

4. Field Representative: The OEM shall provide the services of a qualified field representative for all startup and commissioning procedures. The representative shall perform all testing, operation, and debugging of the systems.
5. Training
    a. The OEM shall provide the services of a qualified representative for 5 days to instruct the Owner's personnel on proper operation, installation, sampling, cleaning, and maintenance for the membrane system.
        1) General Background: Ions, organics, bacteria, fungi, algae, sand, silt, clay, colloids, principles of diffusion, dissolved substances, and suspended substances. How nanofiltration works, Principles of net driving pressure. Semipermeable membranes, cellulosic and non-cellulosic. How membranes reject ions, organics, and particles. How NF elements are made and how they work.
        2) NF Skid Operation: The internal and external pieces of a nanofiltration skid. What happens inside the nanofiltration skid. Problems caused by dissolved substances. Why and how scaling and chemical attack occur. Problems caused by suspended substances. Why and how fouling by bacteria and inorganic particles occur. Pretreatment equipment and chemicals used to minimize operating problems. Monitoring techniques such as permeate flow normalization, percent salt rejection, pressure drops, and silt density index to detect problems.
        3) Maintenance: Issues involving the maintenance of the NF skids.
        4) Controls/operation of this specific installation including touch screens, logic, and operations.
6. The OEM shall provide at least two (2) qualified field representatives to be on-site to coordinate and supervise the installation (1 week) and startup and commissioning (3 weeks) of the NF system for each WTP facility. Some time may be combined with that required for the other equipment provided by the OEM.

D. Remote Monitoring: The OEM shall provide two (2) years of monitoring of all of the system operating parameters. Owner to provide OEM will required data (VPN connection is not permitted). The OEM shall provide a monthly status report with a complete analysis of all normalized data with recommendations for operation and maintenance. The period of remote monitoring shall commence upon Substantial Completion of the project.

E. Field Service Agreement: The OEM shall provide a two (2) year service agreement to the Owner. Service agreement shall include all costs (including labor, travel, lodging, meals, and incidentals) for the following for each WTP facility:
    1. Two (2) trips for a qualified field representative to be on-site to assist the Owner in troubleshooting and/or operation of the Nanofiltration Membrane Equipment. Each trip shall consist of four (4) full days of service. Travel days excluded from number of days of service.
    2. Two (2) trips for a qualified field representative to be on-site to assist the Owner in performing membrane cleaning. Each trip shall consist of three (3) full days of service. Travel days excluded from number of days of service.

END OF SECTION 46 6340

RARWTP RO MEMBRANE EQUIPMENT SCHEDULE

A. Performance Requirements
   1. The raw water source is groundwater from wells which has been oxidized with sodium hypochlorite, filtered with gravity filters, and chemically conditioned to reduce ORP and provide antiscalant. Table 1 presents the water quality data which shall be used in the development of the RO system design.
   2. Each NF train shall meet the permeate quality requirements specified in Table 1 throughout the performance warranty period while operating at the design recovery and permeate flowrate.

Table 1 – RARWTP Water Quality Data

Parameter	Unit	Raw Water	Permeate Requirements
NH4+ +NH3	mg/L	0.00	
K	mg/L	2.9	
Na	mg/L	33	
Mg	mg/L	27	
Ca	mg/L	102	
TH	mg/L as CaCO3	366	< 15
Sr	mg/L	0.33	
Ba	mg/L	0.10	
CO3	mg/L	0.27	
HCO3	mg/L	310	
NO3	mg/L	0.56	
Cl	mg/L	63	< 10
F	mg/L	0.20	
SO4	mg/L	52.00	> 0.40
SiO2	mg/L	6.30	
Boron	mg/L	0.00	
TDS	mg/L	597.56	< 30
pH	s.u.	7.11	
Temperature	Degrees F	55-60	

B. NF Skid Design:
   1. No. of Skids: Six (6)
   2. Configuration: 2 Stage, 24:12
   3. No. of Elements per Vessel: 7
   4. Permeate Capacity: 1,030 gpm
   5. Recovery: 80% (adjustable from 70% to 83% to maintain min. concentrate flow of 15 gpm/vessel and a maximum membrane recovery of 19% per element)
   6. Flux: 14.7 gfd
   7. Permeate Backpressure after skid:
      a. Stage 1: 0-35 psig (adjustable)
      b. Stage 2: 0-15 psig

C. NF Skid Dimensions:
   1. Maximum Width: 95 inches (8’-0”)
   2. Maximum Length: 318 inches (26’-6”)
   3. Maximum Height: 150 inches (12’-6”)

D. MCS:
   1. Stage 1
      a. Heater: 120 kW
   2. Stage 2
      a. Heater: 75 kW

FAWTP RO MEMBRANE EQUIPMENT SCHEDULE

A. Performance Requirements
   1. The raw water source is groundwater from wells which has been chemically conditioned to reduce ORP and provide antiscalant. Table 2 presents the water quality data which shall be used in the development of the RO system design.
   2. Each NF train shall meet the permeate quality requirements specified in Table 2 throughout the performance warranty period while operating at the design recovery and permeate flowrate.

Table 2 – FAWTP Water Quality Data

Parameter	Unit	Raw Water	Permeate Requirements
NH4+ +NH3	mg/L	0.00	
K	mg/L	3.0	
Na	mg/L	17	
Mg	mg/L	27	
Ca	mg/L	71	
TH	mg/L as CaCO3	288	< 10
Sr	mg/L	0.75	
Ba	mg/L	0.06	
CO3	mg/L	0.50	
HCO3	mg/L	256	
NO3	mg/L	2.4	
Cl	mg/L	34	< 5
F	mg/L	0.21	
SO4	mg/L	29	> 0.20
SiO2	mg/L	7.7	
Boron	mg/L	0.00	
TDS	mg/L	449	< 25
pH	s.u.	7.5	
Temperature	Degrees F	55-60	

B. NF Skid Design:
   1. No. of Skids: Three (3)
   2. Configuration: 2 Stage, 27:14
   3. No. of Elements per Vessel: 7
   4. Permeate Capacity: 1,198 gpm
   5. Recovery: 80% (adjustable from 70% to 83% to maintain min. concentrate flow of 15 gpm/vessel and a maximum membrane recovery of 19% per element)
   6. Flux: 15.0 gfd
   7. Permeate Backpressure after skid:
      a. Stage 1: 0-35 psig (adjustable)
      b. Stage 2: 0-15 psig

C. Dimensions:
   1. Maximum Width: 95 inches (8’-0”)
   2. Maximum Length: 318 inches (26’-6”)
   3. Maximum Height: 150 inches (13’-2”)

D. MCS:

1. Stage 1
    a. Heater: 120 kW
2. Stage 2
    a. Heater: 75 kW

SECTION 46 6342

SIDE-PORTED PRESSURE VESSELS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this section includes furnishing and installation of all equipment necessary to provide the side-ported pressure vessels for the NF system.

B. Equipment specified under this section shall be provided by the ROEM as part of the membrane treatment system.

C. Equipment furnished and installed under this section shall be fabricated, assembled, erected and placed in proper operating condition in full compliance with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: All pressure vessels specified under this section shall be manufactured and supplied by one manufacturer.

B. Reference Standards: The pressure vessel design must meet all the requirements of ASME Section X, entitled Fiber Reinforced Boilers and Pressure Vessels.

1.4 SUBMITTALS

A. The manufacturer shall provide instructions on installation, operation and maintenance and proper application of the vessels as well as a vessel drawing. Submittals shall conform to the requirements set forth by Division 01 Section "Submittal Procedures". The documents provided shall include the following:

1. Operation and Maintenance Instructions: Step-by-step instructions for opening and closing the vessel along with precautions and recommended maintenance procedures. These instructions shall be written to inform a general mechanic unfamiliar with NF vessels.
2. Installation Instructions: Detailed instructions for handling, mounting and connecting the vessel.
3. Application Guide: General guidelines to assist the NF system engineer to apply vessels correctly to the specific requirements.
4. Engineering Drawing: detailed drawings that specify all parameters necessary to incorporate the vessel component into the NF system, including dimensions, weights, materials of construction and port size.

1.5 SPARE PARTS

A. Spare parts shall be of the same manufacture and quality as those provided with the equipment. Spare parts shall be suitably packaged in accordance with the Manufacturer's recommendations, with labels indicating the contents of each package. Spare parts shall be delivered to the Owner with the equipment of this Section.

B. Provide the following spare parts:
   1. 2 complete pressure vessel heads.

1.6 HANDLING, DELIVERY, AND STORAGE

A. The pressure vessels shall be completely factory assembled and securely crated for shipment.

B. When received at the site, the pressure vessels shall be stored in a clean, dry environment until ready for installation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Pressure vessels shall have a diameter and length designed specifically to contain a quantity of 7 standard eight-inch diameter by 40-inch long spiral-wound membrane elements. The feed and concentrate ports shall be located in the sidewall of the pressure vessel. Vessels with multiple ports per end for direct vessel-to-vessel connection are permitted and required in order to simplify system design, provide a smaller footprint and eliminate excessive manifolds.

B. Vessels shall have a maximum working pressure of not less than 200 PSI at a temperature up to 120 deg F (49 deg C) with a minimum operating temperature of not less than 20 deg F (-7 deg C).

C. Vessels shall be complete with end closures, hardware and membrane element end adapters. Membrane elements and membrane interconnectors shall be furnished by the membrane element manufacturer.

D. The adapters furnished shall be appropriate for the brand of membrane element specified. In addition, the vessel shall be designed to allow other makes of membrane elements to be easily accommodated by changing the adapters.

E. The materials used in the construction of the pressure vessel shall meet ASME code requirements, including material selection and required strength for the anticipated operating conditions. These materials shall also have the following characteristics:
   1. All wetted head components in continuous contact with the pressurized process water shall be made from plastics that are known to have long-term resistance to corrosion in the service intended.
   2. All wetted nozzles in continuous contact with the pressurized process water shall be made from wrought pipe that is known to have long-term resistance to corrosion in the service intended.
   3. All other materials of construction shall be of appropriate strength and corrosion resistance for the operating conditions. The use of an unanodized aluminum and plastic load bearing materials is strictly prohibited.

4. The materials of construction for each component part of the vessel shall be clearly and fully specified on the Engineering Drawing.

F. Manufacturer: Bekaert Progressive Composites, Codeline, Wave Cyber.

2.2 VESSEL SAFETY

A. Vessels shall be designed to meet the standards of ASME Boiler and Pressure Vessel Code, Section X. Vessels shall be certified by manufacturer. Code stamp is not required.
   1. The Manufacturer shall be qualified to produce Code Certifiable Pressure Vessels per Section X of the Code as verified by possession of a current Certificate of Authorization issued by the ASME.
   2. Vessels shall be built to a design that has been qualified for fabrication through ASME Design and Procedure Qualification Tests. The tests include destructive pressure tests of prototype vessels. To qualify, a prototype must not burst at less than six times (6X) its rated pressure after being pressure cycled 100,000 times at 150 deg F.
   3. Vessels shall be fabricated so as to duplicate the qualified design through compliance with the ASME approved Procedure Specification written for the prototype. Proof of conformance is established through the workings of the ASME approved Quality Control System.
   4. Vessels shall be tested to assure conformance with the qualified design through ASME Quality Control and Production Tests. Each vessel undergoes ASME Production Tests, which include a Hydrostatic Leakage Test, at a pressure of 1.1 times the rated pressure.
   5. A third party ASME Authorized Inspector shall inspect vessels during fabrication in order to assure conformance with the qualified design.
   6. The materials shall be approved for use in pressure vessel construction by the standards of the ASME Boiler and Pressure Vessel Code. Such materials shall meet the following criteria:
      a. Materials of construction shall be certified by the manufacturer to meet Code standards where applicable and shall be lot traceable to the vessel serial number.

2.3 VESSEL SHELL

A. Pressure vessels shall be designed for ease of use and fail-safe operation. The vessels shall include the following:
   1. In order to provide superior long-term strength, the locking ring groove shall be integrally filament wound into the I. D. of the vessel. In addition, each grove shall incorporate an integrally wound 316L stainless steel insert for added groove durability and improved corrosion resistance. Cutting or grinding of fibers to form the locking ring groove is not acceptable as this may weaken the shell and directly affect the safety and service life of the vessel.
   2. The shell bore shall be fabricated from a resin-rich epoxy barrier that has been cured to allow for superior corrosion resistance, minimal extractables, improved life and high temperature (176 deg F/80 deg C) operation. Winding over plastic pipe is not acceptable under any circumstance.
   3. The shell of the vessel shall be fabricated of filament-wound fiberglass reinforced plastic (FWFRP) using continuous glass roving, impregnated with an elevated temperature cure epoxy resin system to provide superior dimensional stability and long term service life. The use of single monomer resin such as polyester is strictly prohibited.
   4. Each shell inside diameter shall be free of pits or voids that may promote bacterial growth or corrosive attack of the resin-rich barrier and shall conform to level 1 criteria as

ASME Section X, section 6-100.1. The bore diameter shall be a mirror-like, smooth surface and meet the following measurement criteria throughout the membrane interface area:

Nominal 8-inch diameter 7.955 ± .005.

5. Each shell shall have an exterior surface that has been coated with a two-part polyurethane enamel for superior gloss retention, abrasion resistance and to block light that may promote biological growth. Each end-bell shall be free of any grinding or sanding marks. The length of the shell between the bells shall be straight without any lumpiness that may indicate filament-winding inconsistency that could affect performance.
6. The shell shall be fail-safe to prevent catastrophic failure while in service. The head retention system shall fail at a nominal value of not less than 6 times design pressure to prevent the possibility of catastrophic failure while in service.

2.4 VESSEL HEAD

A. Each vessel head shall be designed for removal by hand under normal operating conditions. In addition, each head shall feature a secondary removal means (such as female threads) to assist in head removal as required throughout the service life of the vessel.

B. Each vessel head shall be constructed from ASME approved metal materials for indirect load bearing applications. The use of thermoplastics for direct load bearing applications is strictly prohibited.

C. The primary means for head retention shall be a single retaining mechanism that provides ASME-required redundancy and is constructed of stainless steel for ease of use and long term reliability and shall be able to be removed by hand, without the use of any tools to reduce operation and maintenance costs.

D. Each head shall contain an integral stainless steel secondary interlock that requires a simple, yet specific sequence of events to remove the end closure and shall not require the use of separate components that may become separated from the vessel. The use of plastic secondary interlock mechanisms that may become damaged by wear or environmental exposure are prohibited.

E. The surfaces of the head that come in contact with the process fluid shall be constructed from PVC or other inert plastic to eliminate any problems with metal corrosion such as pitting or crevice corrosion.

F. Permeate Port
   1. The permeate port shall be 1-1/2-inch NPT male or 1-1/2-inch grooved end, as recommended by the ROEM and as approved by the Engineer.
   2. The permeate port shall be constructed from PVC.
   3. Each permeate port shall be designed with an anti-rotation mechanism so that piping may be easily tightened.

G. Permeate Sampling Valve
   1. The feed end permeate port of each pressure vessel shall be fitted with a 1/4-inch diameter thermoplastic ball valve that has been designed exclusively for membrane probing without excess permeate water loss.

2. The valve shall include a gripper nut that can be easily tightened and loosened by hand throughout the probing process.
3. The nut ferrule shall include an o-ring seal to prevent leakage during operation.
4. The valve shall be attached to the permeate port with a 1/4-inch 316 stainless steel nipple.

2.5 VESSEL SIDE PORTS

A. Each side-ported feed/concentrate port shall be 2-1/2-inch diameter and constructed of wrought stainless steel pipe and shall be designed to interface the flexible grooved coupling. The port shall be marked for complete traceability with the part number and the heat lot of the material that can be traced to batch related corrosion test performance. The use of investment cast materials is prohibited.

B. Each side-ported feed/concentrate port shall be designed so that they may be removed and replaced in the field by the end user without the use of special tools.

C. The use of multiple ported vessels that allow direct vessel to vessel connections is permitted providing the following provisions are met:
1. No more than three pressure vessels shall be connected to one feed/concentrate manifold connection without approval.
2. The pressure drop between each connected set of three vessels shall not have a pressure differential in excess of 3 PSI.
3. All multiple port connections shall be sized to limit feed water flow velocities to no more than 11 Feet per second. In addition membrane cleaning flow requirements must be considered when multiple porting is to be used.
4. The feed manifold and concentrate manifold shall be located on opposite sides of each set of pressure vessels to ensure correct flow balancing. Design layouts that locate the feed manifold and concentrate manifold on the same side of each set of pressure vessels shall not be used without prior approval of the Engineer.

D. Each side-ported feed/concentrate port shall be completely flush with the inside surface of the vessel so as to not interfere with membrane element loading. Ports that are in any way raised into the interior surface of the vessel shall not be acceptable.

E. Each side port shall feature a direct metal to composite interface. The compression loading of any non-code material, such as thermoplastic that may creep under pressure, is not permitted.

2.6 VESSEL SEALS

A. In order to assure field serviceability, all seals, whether in the shell or head, shall be visible so as to be directly accessible for replacement without the removal of any other components. Seal designs that do not eliminate dead space and may lead to biological growth are strictly prohibited.

B. All permeate connection seals shall be designed to prevent rolling that may lead to seal damage.

C. All permeate connection seals shall be peroxide-cured ethylene propylene (EPDM) rubber to increase seal life and reduce the effects of permanent compression set.

D. Vessels shall not leak when properly installed. If leaking occurs, the vessel supplier is responsible for the repair or replacement of the vessel. Such leaking must be remedied within 14 working days from the notification of the leak.

E. Each Head Seal shall be so designed to minimize cross sectional thickness to reduce the friction required for head installation and removal.

F. Each head seal gland shall be designed to eliminate dead space and to expose the seal surface to high-pressure fluid for flushing of the seal in order to minimize bacterial growth.

G. Each head seal gland shall be located on the head of the vessel and shall partially capture the seal, so that it remains on the head at all times, even during head removal, without becoming separated from the head, which may cause seal damage, misplacement or vessel leakage.

H. Each side-ported feed/concentrate port shall incorporate an elastomeric seal that seals to vessel shell so that edge laminate surfaces are not exposed. Side port designs that do not eliminate seal dead space and may lead to biological growth are strictly prohibited.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's printed instructions.

B. The NFEM shall provide documentation that the membrane skid piping design allows for expansion and contraction of the pressure vessels and that the system is designed in accordance with the vessels manufacturer's recommendations.

3.2 TESTING

A. After installation, conduct pressure and leakage tests for each vessel as part of the membrane skid tests in accordance with Division 46 Section "Nanofiltration Membrane Equipment".

B. Prior to membrane element installation, thoroughly clean, flush, and disinfect the pressure vessels. All disinfectant solution shall be completely flushed from the pressure vessels prior to membrane element installation.

END OF SECTION 46 6342

TO ALL DOCUMENT HOLDERS:

Subject: WCWSD RARWTP Membrane Softening Upgrades

AECOM Job No.: 60551697

Enclosed herewith is a copy of Addendum No. 1 covering the subject project.

Please retain this with your Documents.

Sincerely,

AECOM

Matthew Noelker, P.E.

Attachments:

Specifications:

1. Section 00 4113 – Bid Form
2. Section 00 7343 – Wage Rate Determination
3. Section 40 9443 – Plant Control System (FAWTP)

Drawings:

1. GP-15 – Valve Schedule (FAWTP)

ADDENDUM TO THE
BIDDING DOCUMENTS
FOR:
Membrane Equipment Procurement

1.1 GENERAL

A. This Addendum covers changes to the Documents and in closing the Contract will become a part thereof. Each Bidder shall include these items to the extent they affect his Bid.

B. These items modify only the portion of the Documents specifically noted. All other wording and Drawings remain in effect.

1.2 CLARIFICATIONS

A. The following is a list of clarifications regarding project documents. These clarifications include question received during the advertisement period:

Q: Please confirm that the assembly of goods onsite is in the scope of work of the OEM.

A: Yes, assembly of good onsite is in the scope of work of the OEM. This shall be included on the appropriate line items of the Bid Form. OEM will be responsible for these costs and these costs will be included in the Contract between the Seller and the Buyer.

Q: Please confirm that the value of the Contract between the Seller and the Buyer is equal to the total lump sum of the base bid (or the total lump sum of the alternate bid).

A: Yes, the total value of the Contract between the Seller and the Buyer will be equal to the total lump sum base bid (or the total lump sum alternate bid). Note that the Seller will likely have to enter into Contract with two different Buyers as the RARWTP and FAWTP construction contracts are being bid separately.

Q: In Section 40 0523 – Valves, Gates, and Accessories, paragraph 2.3.K.2, are Hayward BYV Series PVC butterfly valves an acceptable manufacturer?
A: If this valve meets the product specifications, it will be accepted.

Q: In Section 40 0523 – Valves, Gates, and Accessories, paragraphs 2.6.P and 2.7.P, is Rotork an acceptable manufacturer?
A: No. AUMA actuators must be provided.

Q: In Section 40 9100 – Primary Sensors and Field Instruments, paragraph 2.3.A.4, are Rosemount 8750W or Endress + Hauser W400 acceptable manufacturers?
A: No. Siemens Sitrans Series 5100 flow meters and 5000 Series transmitters must be provided.

Q: In Section 46 6340 – Nanofiltration Membrane Equipment, paragraphs 2.9.F.1 and 2.10.F.1, please clarify what is meant by “accessories”.
A: This includes any supports, mounting components, and any specific accessories identified in Section 40 9100 – Primary Sensors and Field Instruments.

Q: In Section 46 6340 – Nanofiltration Membrane Equipment, paragraphs 2.9.F.1 and

2.10.F.1, please clarify who is providing the conduit and wiring between instrumentation and MCS/Permeate Flush Panel(s).
A: This conduit and wiring will be provided by the General Contractor. See clarifications below in the project manual and the drawings.

Q: Please confirm that factory acceptance testing is required for skids that will be shipped to site unassembled for on-site assembly.

A: Factory acceptance testing of fully assembled skids is required for all skids, regardless of method of shipping and assembly. Refer to Section 46 6340 – Nanofiltration Membrane Equipment" paragraph 3.2.A for factory acceptance testing requirements.

Q: What motor size is being provided for the MCS pumps and the permeate flush pump?
A: These pumps will each have a maximum motor size of 60 hp.

1.3 PROJECT MANUAL

A. Section 00 1113 – Advertisement for Bids
   1. Section 2 – Revise "Bids will be received by Engineer until May 15, 2020 @ 2 p.m." to read "Bids will be received by Engineer until May 18, 2020 @ 2 p.m."

B. Section 00 4113 – Bid Form
   1. This section is being revised and reissued as an attachment to this addendum.

C. Section 00 7343 – Wage Rate Determination
   1. This Section is being issued as an attachment to this addendum.

D. Section 26 2200 Transformers
   1. Paragraph 2.2.A – Delete "b. General Electric Company."

E. Section 26 2913 Motor Controllers
   1. Paragraph 2.7.A – Modify the following text to read:
      a. "2. Eaton Corporation."
   2. Paragraph 2.7.A – Delete the following text:
      a. "3. Square D."

F. Section 40 9000 Plant Instrumentation and Control System General Requirements
   1. Paragraph 1.1.B – Delete the entire last sentence starting with "Unit process logic residing…"

G. Section 40 9443 Plant Control System (FAWTP)
   1. This section is being revised and reissued as an attachment to this addendum.

H. Section 40 9443 Plant Control System (RARWTP)
   1. Paragraph 2.1 B.1 – Modify the following text to read:
      a. "b. Color TFT LCD"
      b. "c. 18-bit color graphics"
      c. "h. NEMA 4X"
      d. "j. 512 MB RAM and 512 MB user storage"
   2. Paragraph 2.1 B.2 – Modify the following text to read:

a. “a. Allen-Bradley, PanelView Plus 7 Performance”

I. Section 46 6340 – Nanofiltration Membrane Equipment
1. Paragraph 2.3. Add the following as subparagraph G:
“Velocities in piping shall not exceed 9 feet per second except in control valves or flow metering sections.”
2. Paragraph 2.8.A – Revise “floor-mounted where indicated by the Drawings, adjacent to each skid” to read “mounted on the skid”.
3. Paragraph 2.9.F.1 – Delete the following:
“Conduit and wiring between instrumentation and MCS shall be provided by OEM. Conduit and wiring shall comply with Division 26 and 409XXX series specifications.” This conduit and wiring will be provided by the General Contractor.
4. Paragraph 2.10.A – Delete this paragraph.
5. Paragraph 2.11.A.3 – Revise to read as follows:
“Provide 500 filters for each WTP.”
6. Paragraph 2.16.C. Add the following as subparagraph 8:
“Operator shall have the ability to enter the desired maximum flux for stage 1 of the membrane array. The stage 1 permeate throttling valve shall be automatically controlled to maintain this maximum flux rate.”
7. RARWTP RO Membrane Equipment Schedule:
a. Table 1 – RARWTP Water Quality Data – Delete the row with the SO4 Parameter.
b. Table 1 – Add the following footnote: “TDS shall be calculated using the gravimetric analysis method.”
8. FAWTP RO Membrane Equipment Schedule:
a. Table 1 – FAWTP Water Quality Data – Revise TH Permeate Requirements “<10” to “<15”.
b. Table 1 – FAWTP Water Quality Data – Delete the row with the SO4 Parameter.
c. Table 1 – Add the following footnote: “TDS shall be calculated using the gravimetric analysis method.”

1.4 DRAWINGS

A. E-06 (RARWTP). Note that this work is part of the General Contractor’s scope.
1. Add Coded Note 16 symbol adjacent to the Membrane Cleaning System Control Panel. Under Coded Note 15, add Coded Note 16 text that reads, "PROVIDE CONTROL, ANALOG, AND POWER CONDUIT AND WIRES FROM THE MEMBRANE CLEANING SYSTEM CONTROL PANEL TO THE MEMBRANE CLEANING SYSTEM COMPONENTS. CONTROL CONDUITS SHALL BE 3/4" WITH (2)#14+(1)#14G FOR EACH CONTROL DEVICE. ANALOG CONDUITS SHALL BE 1" WITH (1) STP FOR EACH ANALOG DEVICE. POWER CONDUITS SHALL BE 1.25" WITH (3)#4+(1)#8G VFD CABLES FOR EACH PUMP, 2" CONDUIT WITH (3)#1/0+(1)#6G FOR THE 120KW HEATER, AND 1.5" CONDUIT WITH (3)#1+(1)#6G FOR THE 75KW HEATER."

B. GP-15 Valve Schedule (FAWTP)
1. This sheet is being revised and reissued as an attachment to this addendum.

C. E-09 (FAWTP). Note that this work is part of the General Contractor’s scope.
1. Add Coded Note 18 symbol adjacent to the Membrane Cleaning System Control

Panel. Under Coded Note 17, add Coded Note 17 text that reads, "PROVIDE CONTROL, ANALOG, AND POWER CONDUIT AND WIRES FROM THE MEMBRANE CLEANING SYSTEM CONTROL PANEL TO THE MEMBRANE CLEANING SYSTEM COMPONENTS. CONTROL CONDUITS SHALL BE 3/4" WITH (2)#14+(1)#14G FOR EACH CONTROL DEVICE. ANALOG CONDUITS SHALL BE 1" WITH (1) STP FOR EACH ANALOG DEVICE. POWER CONDUITS SHALL BE 1.25" WITH (3)#4+(1)#8G VFD CABLES FOR EACH PUMP, 2" CONDUIT WITH (3)#1/0+(1)#6G FOR THE 120KW HEATER, AND 1.5" CONDUIT WITH (3)#1+(1)#6G FOR THE 75KW HEATER."

END OF ADDENDUM NO. 1
(SEE ENCLOSURES)

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THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

SECTION 00 4113

BID FORM

TABLE OF CONTENTS

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to the Engineer via email or via hand delivery, USPS, UPS, or FedEx to:

AECOM
ATTN: Matthew Noelker, P.E.
277 West Nationwide Blvd
Columbus, Ohio 43215
Matthew.noelker@aecom.com

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Buyer in the form included in the Bid Documents to furnish the Goods and Special Services as specified or indicated in the Bid Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bid Documents.

1.03 The Buyer of the Goods and Special Services will be the successful Bidder(s) (Contractor(s)) for the referenced Projects.

ARTICLE 2 – BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the RFP.

2.02 Bidder accepts the provision of the Agreement as to liquidated damages in event of its failure to furnish the Goods and Special Services in accordance with the schedule set forth in the Agreement.

ARTICLE 3 – BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bid Documents included with the RFP, other related data identified, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date
_____	_____
_____	_____
_____	_____
_____	_____

B. Bidder has become familiar with and is satisfied as to the local conditions that may affect cost, progress, delivery, or the furnishing of Goods and Special Services.

C. Bidder is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress, and the furnishing of Goods and Special Services.

D. Bidder has carefully studied and correlated the information known to Bidder, and information and observations obtained from Bidder's visits, if any, to the Point of Destination with the Bid Documents.

E. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bid Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

F. The Bid Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing the Goods and Special Services for which this Bid is submitted.

G. Bidder further represents that this Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any individual or entity to refrain from Bid; and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Buyer.

ARTICLE 4 – BASIS OF BID

ADD #1

4.01 Bidder will furnish the Goods and Special Services in accordance with these Contract Documents for the following price(s), which do not include sales tax. Prices shall be guaranteed until August 31, 2020. After this date, **if the Owner has not issued a Notice to Proceed to Buyer, and** if requested by the ~~**Buyer**~~ **Seller** and approved by the Owner, ~~**Buyer's**~~ **Seller's** proposed prices may be escalated by the monthly change of the U.S. Consumer Price Index (CPI) as calculated by the U.S. Bureau of Labor Statistics.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

RARWTP

ADD #1

Item No.	Description	Proposed Price
	SHOP DRAWINGS	
1.)	Shop Drawing Preparation	
	EQUIPMENT	
2.)	Base Bid: Manufacturing of Goods—Epoxy Coated or FRP Frames Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	
3.)	Base Bid: Assembly of Goods Onsite—Epoxy Coated or FRP Frames Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	
4.)	Alternate Bid: Manufacturing of Goods—304 SST Frames (Item cost is additive or deductive from Item No. 2). Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	Add / Deduct (Circle One)
5.)	Alternate Bid: Assembly of Goods Onsite—304 SST Frames (Item cost is additive or deductive from Item No. 3). Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	Add / Deduct (Circle One)
	SPECIAL SERVICES	
6.)	Include costs required for all Special Services including startup and commissioning, remote monitoring, and field service agreement.	

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

FAWTP

ADD #1

Item No.	Description	Proposed Price
	SHOP DRAWINGS	
7.)	Shop Drawing Preparation	
	EQUIPMENT	
8.)	Base Bid: Manufacturing of Goods—Epoxy Coated or FRP Frames Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	
9.)	Base Bid: Assembly of Goods Onsite—Epoxy Coated or FRP Frames Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	
10.)	Alternate Bid: Manufacturing of Goods—304 SST Frames (Item cost is additive or deductive from Item No. 2). Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	Add / Deduct (Circle One)
11.)	Alternate Bid: Assembly of Goods Onsite—304 SST Frames (Item cost is additive or deductive from Item No. 3). Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	Add / Deduct (Circle One)
	SPECIAL SERVICES	
12.)	Include costs required for all Special Services including startup and commissioning, remote monitoring, and field service agreement.	

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

TOTALS

RARWTP TOTAL LUMP SUM BASE BID
(1 + 2 + 3 + 6):

_____ Dollars $_____
(Words) (Figures)

RARWTP TOTAL LUMP SUP ALTERNATE BID
(1 + 2 + 3 + 4 + 5 + 6):

_____ Dollars $_____
(Words) (Figures)

FAWTP TOTAL LUMP SUM BASE BID
(7 + 8 + 9 + 12):

_____ Dollars $_____
(Words) (Figures)

FAWTP TOTAL LUMP SUP ALTERNATE BID
(7 + 8 + 9 + 10 + 11 + 12):

_____ Dollars $_____
(Words) (Figures)

TOTAL LUMP SUM BASE BID (RARWTP + FAWTP)

_____ Dollars $_____
(Words) (Figures)

TOTAL LUMP SUP ALTERNATE BID (RARWTP + FAWTP)

_____ Dollars $_____
(Words) (Figures)

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

4.02 Additional Proposed Costs:

Description	Proposed Price
The Seller's monthly fee for storage of Goods at Seller's facilities in the event that Buyer desires to delay shipment beyond the shipment date stated below in Article 5.02. Such fee shall include interest on money due Seller.	
The Seller's monthly fee for Buyer delaying the initiation of manufacturing of Goods or for not executing the Procurement Agreement within the time specified in 4.03 below.	

4.03 Seller and Buyer shall execute the Procurement Agreement within 30 days after the Contractor's/Buyer's Notice to Proceed from the Owner. Should the Procurement Agreement not be executed within said 30 days due to the fault of the Buyer, the Buyer shall be subject to the prorated additional costs identified in Paragraph 4.02 above. Should the Procurement Agreement not be executed within the said 90 days due to the fault of the Seller, Seller shall be subject to the liquidated damages provisions in the Procurement Agreement. The issue of fault will be determined by the Engineer.

ARTICLE 5 – TIME OF COMPLETION

5.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedules set forth below, which will be incorporated into Article 5 of the Agreement.

ADD #1

Description:	Proposed Number of Consecutive Calendar Days:
Time required by Seller to submit approvable Shop Drawings (consecutive calendar days after Notice to Proceed is issued to Buyer)	**(maximum of 30 days)**
~~Time required by Seller after receipt of approved Shop Drawings to deliver acceptable Goods to Point of Destination:~~ **Time required by Seller to deliver acceptable Goods to Point of Destination and complete assembly of goods onsite (consecutive calendar days after Notice to Proceed is issued by Buyer).** (consecutive calendar days)	**(maximum of 150 days)**
~~Time required by Seller to complete assembly of goods onsite~~ ~~(exclude time for unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power)~~	
Time required by Seller to complete all Special Services (consecutive calendar days after notification from Buyer to	

Seller to commence such Special Services.):	
Time required by Seller to be ready for Final Inspection and Acceptance of all Goods and all Special Services (consecutive calendar days after notification from Buyer to Seller to commence such Special Services.):	

5.02 Bidder agrees that the prices in Article 4 above are based on the condition that shipment of goods may be delayed by the Buyer.

ARTICLE 6 – BID DOCUMENTS

6.01 The following documents are attached with and made a condition of this Bid:

A. Attachment 1: Bidder Qualifications

B. Attachment 2: Scope of Supply

C. Attachment 3: OEM Special Services

D. Attachment 4: OEM Warranty

E. Attachment 5: Installation Instructions and Contractor's Responsibilities

F. Attachment 6: Spare Parts

ARTICLE 7 – DEFINED TERMS

7.01 The terms used in this Bid have the meanings indicated in the General Conditions. The significance of terms with initial capital letters is described in the General Conditions.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

ARTICLE 8 – BID SUBMITTAL

8.01 This Bid is submitted by:

If Bidder is:

A Partnership

Partnership Name: _____

By: _____
(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed): _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____
Type (General Business, Professional, Service, Limited Liability):_____

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____
(CORPORATE SEAL)

Attest _____

Date of Qualification to do business in Ohio is ____/____/____.

A Joint Venture

Name of Joint Venture: _____

First Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of first joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Second Joint Venturer Name: _____(SEAL)

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

By: _____
(Signature of second joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

Bidder's Business Address _____

_____

Phone No. _____ Fax No. _____

E-mail _____ _____

SUBMITTED on _____, 20____.

END OF SECTION 00 4113

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

SECTION 00 7343

WAGE RATE REQUIREMENTS

PART 1 GENERAL

1.1 REFERENCE

A. Prevailing wage rates, as determined by the United States Department of Labor for Warren County, the county in which the project is located, shall be used in accordance with the provisions of the Davis-Bacon Wage determinations as provided in 29 CFR 1.5 and 1.6(b). A copy of these rates is attached.

1.2 USE

A. Keep posted at all times throughout the Contract period the wage rate pages that are effective at the time of Bid opening.

B. Maintain, throughout the construction period, a legible up-to-date copy. Post in a conspicuous place accessible to workers and protected from the weather.

C. The successful Bidder shall be required to conform to all provisions of the Federal Davis-Bacon and Related Acts (The Act) which requires that all laborers and mechanics employed by contractors and subcontractors performing on federal contracts (and contractors and subcontractors performing on federally assisted contracts under the related ACTS) in excess of $2,000 pay their laborers and mechanics not less than the prevailing wage rates and fringe benefits, as determined by the Secretary of Labor, for corresponding classes of laborers and mechanics employed on similar projects in the area.

D. All Bidders must abide by the latest prevailing wage rate listing effective at the time of Bid opening.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 7343

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

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"General Decision Number: OH20200103 02/07/2020

Superseded General Decision Number: OH20190103

State: Ohio

Construction Type: Building

County: Warren County in Ohio.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate,if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	02/07/2020

ASBE0008-010 07/01/2019

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR	$ 30.32	18.50

BROH0018-003 06/01/2019

	Rates	Fringes
BRICKLAYER	$ 27.01	15.02

BROH0018-005 09/01/2019

	Rates	Fringes
TILE SETTER	$ 28.74	14.06

CARP0002-016 05/01/2017

	Rates	Fringes
CARPENTER (Form Work Only)	$ 25.98	15.98

CARP0002-018 05/01/2017

	Rates	Fringes
CARPENTER (Includes Acoustical Ceiling Installation, Drywall Hanging and Metal Stud Installation; Excludes Form Work)	$ 24.04	15.29

ELEC0648-002 09/02/2019

	Rates	Fringes
ELECTRICIAN (Excludes Low Voltage Wiring)	$ 30.00	19.85

* ELEV0011-002 01/01/2020

	Rates	Fringes
ELEVATOR MECHANIC	$ 47.23	34.765+a+b

PAID HOLIDAYS:

a. New Year's Day, Memorial Day, Independence Day, Labor Day, Vetern's Day, Thanksgiving Day, the Friday after Thanksgiving, and Christmas Day.

b. Employer contributes 8% of regular hourly rate to vacation pay credit for employee who has worked in business more than 5 years; 6% for less than 5 years' service.

ENGI0018-036 05/01/2019

	Rates	Fringes
POWER EQUIPMENT OPERATOR Backhoe/Excavator/Trackhoe; Bulldozer; Crane	$ 37.14	15.20

ENGI0018-037 05/01/2018

	Rates	Fringes
POWER EQUIPMENT OPERATOR Bobcat/Skid Steer/Skid Loader	$ 35.89	15.09

ENGI0066-045 06/01/2017

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Forklift	$ 28.87	19.66
Grader/Blade	$ 32.42	19.66
Mechanic	$ 32.92	19.66

IRON0044-003 06/01/2017

	Rates	Fringes
IRONWORKER, REINFORCING	$ 27.60	20.70

IRON0044-020 06/01/2019

	Rates	Fringes
IRONWORKER, ORNAMENTAL	$ 29.47	21.20

LABO0265-019 06/01/2018

	Rates	Fringes
LABORER		
Mason Tender - Brick	$ 21.95	16.20

PAIN0123-001 05/01/2019

	Rates	Fringes

PAINTER (Brush and Roller)	$ 25.30	10.20

PAIN0387-002 11/01/2017

	Rates	Fringes
GLAZIER	$ 26.00	14.15

PLAS0132-018 06/01/2019

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 24.50	14.60

PLAS0132-019 06/22/2018

	Rates	Fringes
PLASTERER	$ 24.25	14.65

PLUM0392-004 06/01/2019

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe Installation, Excludes HVAC Unit Installation)	$ 32.81	21.27
PLUMBER (Includes HVAC Unit Installation, Excludes HVAC Pipe Installation)	$ 32.81	21.27

ROOF0042-007 08/01/2019

	Rates	Fringes
ROOFER	$ 28.25	16.27

SFOH0669-009 04/01/2019

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers)	$ 37.78	23.55

SHEE0024-029 06/01/2019

	Rates	Fringes
SHEET METAL WORKER (Including HVAC Duct Installation Only)	$ 30.16	21.08

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* UAVG-OH-0021 01/01/2019

	Rates	Fringes
OPERATOR: Oiler	$ 27.56	16.37

SUOH2012-105 08/29/2014

	Rates	Fringes
ELECTRICIAN (Low Voltage Wiring Only)	$ 22.62	8.76
IRONWORKER, STRUCTURAL	$ 25.24	17.80
LABORER: Asphalt, Includes Raker, Shoveler, Spreader and Distributor	$ 26.19	8.99
LABORER: Common or General	$ 23.09	7.41
LABORER: Landscape & Irrigation	$ 23.60	0.87
LABORER: Mason Tender - Cement/Concrete	$ 23.87	9.80
LABORER: Pipelayer	$ 23.18	8.95
OPERATOR: Loader	$ 29.66	12.61
OPERATOR: Paver (Asphalt, Aggregate, and Concrete)	$ 30.28	13.29
OPERATOR: Roller	$ 29.85	12.00
PAINTER: Spray	$ 22.78	12.40
TILE FINISHER	$ 22.31	10.24
TRUCK DRIVER: Dump (All Types)	$ 24.32	11.73

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave

for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

"General Decision Number: OH20200001 04/10/2020

Superseded General Decision Number: OH20190001

State: Ohio

Construction Types: Heavy and Highway

Counties: Ohio Statewide.

Heavy and Highway Construction Projects

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate,if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	01/24/2020
2	02/07/2020
3	03/13/2020
4	03/20/2020
5	04/10/2020

BROH0001-001 06/01/2019

DEFIANCE, FULTON (Excluding Fulton, Amboy & Swan Creek Townships), HENRY (Excluding Monroe, Bartlow, Liberty,

Washington, Richfield, Marion, Damascus & Townships & that part of Harrison Township outside corporate limits of city of Napoleon), PAULDING, PUTNAM and WILLIAMS COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0001-004 06/01/2019

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 29.34	16.11

BROH0003-002 06/01/2019

FULTON (Townships of Amboy, Swan Creek & Fulton), HENRY (Townships of Washington, Damascus, Richfield, Bartlow, Liberty, Harrison, Monroe, & Marion), LUCAS and WOOD (Townships of Perrysburg, Ross, Lake, Troy, Freedom, Montgomery, Webster, Center, Portage, Middleton, Plain, Liberty, Henry, Washington, Weston, Milton, Jackson & Grand Rapids) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0005-003 05/01/2019

CUYAHOGA, LORAIN & MEDINA (Hinckley, Granger, Brunswick, Liverpool, Montville, York, Homer, Harrisville, Chatham, Litchfield & Spencer Townships and the city of Medina)

	Rates	Fringes
BRICKLAYER		
BRICKLAYERS; CAULKERS; CLEANERS; POINTERS; & STONEMASONS	$ 34.85	16.94
SANDBLASTERS	$ 35.10	16.94
SEWER BRICKLAYERS & STACK BUILDERS	$ 35.35	16.94
SWING SCAFFOLDS	$ 35.35	16.94

BROH0006-005 06/01/2019

CARROLL, COLUMBIANA (Knox, Butler, West & Hanover Townships),

STARK & TUSCARAWAS

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0007-002 06/01/2019

LAWRENCE

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0007-005 06/01/2019

PORTAGE & SUMMIT

	Rates	Fringes
BRICKLAYER	$ 29.34	16.11

BROH0007-010 06/01/2019

PORTAGE & SUMMIT

	Rates	Fringes
MASON - STONE	$ 29.34	16.11

BROH0008-001 06/01/2019

COLUMBIANA (Salem, Perry, Fairfield, Center, Elk Run, Middleton, & Unity Townships and the city of New Waterford), MAHONING & TRUMBULL

	Rates	Fringes
BRICKLAYER	$ 29.34	16.11

BROH0009-002 06/01/2019

BELMONT & MONROE COUNTIES and the Townships of Warren & Mt. Pleasant and the Village of Dillonvale in JEFFERSON COUNTY

	Rates	Fringes

Bricklayer, Stonemason.....$ 29.34 16.11
Refractory.....$ 31.45 19.01

BROH0010-002 06/01/2019

COLUMBIANA (St. Clair, Madison, Wayne, Franklin, Washington, Yellow Creek & Liverpool Townships) & JEFFERSON (Brush Creek & Saline Townships)

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0014-002 06/01/2019

HARRISON & JEFFERSON (Except Mt. Pleasant, Warren, Brush Creek, Saline & Salineville Townships & the Village of Dillonvale)

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0016-002 06/01/2019

ASHTABULA, GEAUGA, and LAKE COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0018-002 06/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON, PREBLE (Gasper, Dixon, Israel, Lanier, Somers & Gratis Townships) & WARREN COUNTIES:

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0022-004 06/01/2019

CHAMPAIGN, CLARK, CLINTON, DARKE, GREENE, HIGHLAND, LOGAN, MIAMI, MONTGOMERY, PREBLE (Jackson, Monroe, Harrison, Twin, Jefferson & Washington Townships) and SHELBY COUNTIES

	Rates	Fringes

Bricklayer, Stonemason.....$ 29.34 16.11

BROH0032-001 06/01/2019

GALLIA & MEIGS

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0035-002 06/01/2019

ALLEN, AUGLAIZE, MERCER and VAN WERT COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0039-002 06/01/2019

ADAMS & SCIOTO

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0040-003 06/01/2019

ASHLAND, CRAWFORD, HARDIN, HOLMES, MARION, MORROW, RICHLAND, WAYNE and WYANDOT (Except Crawford, Ridge, Richland & Tymochtee Townships) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

FOOTNOTE: Layout Man and Sawman rate: $1.00 per hour above journeyman rate.
Free standing stack work ground level to top of stack; Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: $1.50 per hour above journeyman rate.
""Hot"" work: $2.50 above journeyman rate.

BROH0044-002 06/01/2019

	Rates	Fringes

Bricklayer, Stonemason
COSHOCTON, FAIRFIELD, GUERNSEY, HOCKING, KNOX, KICKING, MORGAN, MUSKINGUM, NOBLE (Beaver, Buffalo, Seneca & Wayne Townships) & PERRY COUNTIES:.....$ 29.34 16.11

BROH0045-002 06/01/2019

FAYETTE, JACKSON, PIKE, ROSS and VINTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 28.65	14.55

BROH0046-002 06/01/2019

ERIE, HANCOCK, HURON, OTTAWA, SANDUSKY, SENECA, WOOD (Perry & Bloom Townships) and WYANDOT (Tymochtee, Crawford, Ridge & Richland Townships) COUNTIES & the Islands of Lake Erie north of Sandusky

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

FOOTNOTE: Layout Man and Sawman rate: $1.00 per hour above journeyman rate.
Free standing stack work ground level to top of stack; Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: $1.50 per hour above journeyman rate.
""Hot"" work: $2.50 above journeyman rate.

BROH0052-001 06/01/2019

ATHENS COUNTY

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0052-003 06/01/2019

NOBLE (Brookfield, Noble, Center, Sharon, Olive, Enoch, Stock,

Jackson, Jefferson & Elk Townships) and WASHINGTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0055-003 06/01/2017

DELAWARE, FRANKLIN, MADISON, PICKAWAY and UNION COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 28.65	14.55

CARP0003-004 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
CARPENTER	$ 26.20	17.42

CARP0069-003 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
CARPENTER	$ 25.98	15.98

CARP0069-006 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
CARPENTER	$ 24.04	15.29

CARP0171-002 05/01/2019

BELMONT, COLUMBIANA, HARRISON, JEFFERSON & MONROE

	Rates	Fringes
CARPENTER	$ 27.37	20.02

CARP0200-002 05/01/2017

ADAMS, ATHENS, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GALLIA,

GUERNSEY, HIGHLAND, HOCKING, JACKSON, LAWRENCE, LICKING, MADISON, MARION, MEIGS, MORGAN, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE, ROSS, SCIOTO, UNION, VINTON and WASHINGTON COUNTIES

	Rates	Fringes
CARPENTER	$ 29.07	16.22
Diver	$ 39.41	10.40
PILEDRIVERMAN	$ 29.07	16.22

CARP0248-005 07/01/2008

LUCAS & WOOD

	Rates	Fringes
CARPENTER	$ 27.27	14.58

CARP0248-008 07/01/2008

	Rates	Fringes
CARPENTER		
DEFIANCE, FULTON, HANCOCK, HENRY, PAULDING & WILLIAMS COUNTIES	$ 23.71	13.28

CARP0254-002 05/01/2017

ASHTABULA, CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
CARPENTER	$ 32.40	16.97

CARP0372-002 05/01/2016

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM & VAN WERT

	Rates	Fringes
CARPENTER	$ 24.54	18.21

CARP0639-003 05/01/2017

MEDINA, PORTAGE & SUMMIT

	Rates	Fringes

CARPENTER	$ 30.42	16.99

CARP0735-002 05/01/2019

ASHLAND, ERIE, HURON, LORAIN & RICHLAND

	Rates	Fringes
CARPENTER	$ 26.30	17.91

CARP1311-001 05/01/2017

BROWN, BUTLER, CHAMPAIGN, CLARK, CLERMONT, CLINTON, DARKE, GREENE, HAMILTON, LOGAN, MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN

	Rates	Fringes
Carpenter & Piledrivermen	$ 29.34	15.95
Diver	$ 40.58	9.69

CARP1393-002 07/01/2008

CRAWFORD, DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Piledrivermen & Diver's Tender...	$ 27.30	16.05

DIVERS - $250.00 per day

CARP1393-003 07/01/2008

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM, VAN WERT & WYANDOT

	Rates	Fringes
Piledrivermen & Diver's Tender...	$ 25.15	15.92

DIVERS - $250.00 per day

CARP1871-006 05/01/2017

BELMONT, HARRISON, & MONROE

	Rates	Fringes

Diver, Wet	$ 48.11	17.33
Piledrivermen; Diver, Dry	$ 32.07	17.33

CARP1871-008 05/01/2017

ASHLAND, ASHTABULA, CUYAHOGA, ERIE, GEAUGA, HURON, LAKE, LORAIN, MEDINA, PORTAGE, RICHLAND & SUMMIT

	Rates	Fringes
Diver, Wet	$ 45.80	18.84
Piledrivermen; Diver, Dry	$ 30.53	18.84

CARP1871-014 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
Diver, Wet	$ 38.34	16.95
Piledrivermen; Diver, Dry	$ 25.56	16.95

CARP1871-015 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
Diver, Wet	$ 37.34	16.07
Piledrivermen; Diver, Dry	$ 24.89	16.07

CARP1871-017 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
Diver, Wet	$ 40.65	17.62
Piledrivermen; Diver, Dry	$ 27.10	17.62

CARP2235-012 01/01/2014

COLUMBIANA & JEFFERSON

	Rates	Fringes
PILEDRIVERMAN	$ 31.74	16.41

CARP2239-001 07/01/2008

CRAWFORD, OTTAWA, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
CARPENTER	$ 23.71	13.28

ELEC0008-002 05/27/2019

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
CABLE SPLICER	$ 38.98	18.96
ELECTRICIAN	$ 40.45	1.5%+20.23

ELEC0032-003 12/02/2019

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Ridgeland, Ridge & Salem Townships)

	Rates	Fringes
ELECTRICIAN	$ 31.37	19.24

ELEC0038-002 04/29/2019

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
ELECTRICIAN		
Excluding Sound & Communications Work	$ 39.13	20.69

FOOTNOTES;
a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

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ELEC0038-008 04/29/2019

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
Sound & Communication Technician		
Communications Technician	$ 27.55	11.98
Installer Technician	$ 26.30	11.94

FOOTNOTES;
a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

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ELEC0064-003 11/25/2019

COLUMBIANA (Butler, Fairfield, Perry, Salem & Unity Townships) MAHONING (Austintown, Beaver, Berlin, Boardman, Canfield, Ellsworth, Coitsville, Goshen, Green, Jackson, Poland, Springfield & Youngstown Townships), & TRUMBULL (Hubbard & Liberty Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.67	15.83

ELEC0071-001 01/01/2019

ASHLAND, CHAMPAIGN, CLARK, COSHOCTON, CRAWFORD, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GUERNSEY, HIGHLAND, HOCKING, JACKSON (Coal, Jackson, Liberty, Milton, Washington & Wellston Townships), KNOX, LICKING, MADISON, MARION, MONROE, MORGAN, MORROW, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, Peepee, Perry & Seal Townships), RICHLAND, ROSS, TUSCARAWAS (Auburn, Bucks, Clay, Jefferson, Oxford, Perry, Salem, Rush, Washington & York Townships), UNION, VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships), and WASHINGTON COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operators	$ 33.62	13.40

Groundmen	$ 24.17	11.32
Linemen & Cable Splicers	$ 38.27	14.42

ELEC0071-004 01/01/2019

AUGLAIZE, CLINTON, DARKE, GREENE, LOGAN, MERCER, MIAMI, MONTGOMERY, PREBLE, and SHELBY COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-005 12/31/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE & LORAIN

	Rates	Fringes
LINE CONSTRUCTION: Equipment Operator		
DOT/Traffic Signal & Highway Lighting Projects	$ 32.44	14.10
Municipal Power/Transit Projects	$ 40.10	16.42
LINE CONSTRUCTION: Groundman		
DOT/Traffic Signal & Highway Lighting Projects	$ 25.06	12.26
Municipal Power/Transit Projects	$ 31.19	14.11
LINE CONSTRUCTION: Linemen/Cable Splicer		
DOT/Traffic Signal & Highway Lighting Projects	$ 36.13	15.03
Municipal Power/Transit Projects	$ 44.56	17.58

ELEC0071-008 01/01/2019

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-010 01/01/2019

BELMONT, CARROLL, HARRISON, HOLMES, JEFFERSON, MEDINA, PORTAGE, STARK, SUMMIT, and WAYNE COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-013 01/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON, and WARREN COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-014 01/01/2019

ADAMS, ATHENS, GALLIA, JACKSON (Bloomfield, Franklin, Hamilton, Lick, Jefferson, Scioto & Madison Townships), LAWRENCE, MEIGS, PIKE (Camp Creek, Marion, Newton, Scioto, Sunfish & Union Townships), SCIOTO & VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships)

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0082-002 12/02/2019

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
ELECTRICIAN	$ 31.15	19.96

ELEC0082-006 11/26/2018

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
Sound & Communication Technician		
Cable Puller	$ 12.18	3.85
Installer/Technician	$ 24.35	11.29

ELEC0129-003 03/25/2019

LORAIN (Except Columbia Township) & MEDINA (Litchfield & Liverpool Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.35	17.30

ELEC0129-004 03/25/2019

ERIE & HURON (Lyme, Ridgefield, Norwalk, Townsend, Wakeman, Sherman, Peru, Bronson, Hartland, Clarksfield, Norwich, Greenfield, Fairfield, Fitchville & New London Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.35	17.30

ELEC0141-003 09/01/2019

BELMONT COUNTY

	Rates	Fringes
CABLE SPLICER	$ 30.63	25.87
ELECTRICIAN	$ 30.38	25.87

ELEC0212-003 11/26/2018

BROWN, CLERMONT & HAMILTON

	Rates	Fringes

Sound & Communication
Technician.....$ 24.35 10.99

ELEC0212-005 06/03/2019

BROWN, CLERMONT, and HAMILTON COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.18	18.89

ELEC0245-001 01/01/2020

ALLEN, HARDIN, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Richland, Ridge & Salem Townships)

	Rates	Fringes
Line Construction		
Equipment Operator	$ 32.37	25.9%+6.75
Groundman Truck Driver	$ 17.70	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75

FOOTNOTE: a. Half day's Paid Holiday: The last 4 hours of the workday prior to Christmas or New Year's Day

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ELEC0245-003 01/01/2020

DEFIANCE, FULTON, HANCOCK, HENRY, HURON, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS, and WOOD COUNTIES

	Rates	Fringes
Line Construction		
Cable Splicer	$ 46.53	25.9%+6.75
Groundman/Truck Driver	$ 17.70	25.9%+6.75
Heli-arc Welding	$ 40.76	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75
Operator - Class 1	$ 32.37	25.9%+6.75
Operator - Class 2	$ 28.32	25.9%+6.75
Traffic Signal & Lighting Technician	$ 36.41	25.9%+6.75

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified

straight-time rates for the work performed on such holiday.

ELEC0245-004 01/01/2020

ERIE COUNTY

	Rates	Fringes
Line Construction		
Cable Splicer	$ 46.53	25.9%+6.75
Groundman/Truck Driver	$ 17.70	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75
Operator - Class 1	$ 32.37	25.9%+6.75
Operator - Class 2	$ 28.32	25.9%+6.75

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

ELEC0246-001 10/29/2018

	Rates	Fringes
ELECTRICIAN	$ 38.00	84%+a

FOOTNOTE: a. 1 1/2 Paid Holidays: The last scheduled workday prior to Christmas & 4 hours on Good Friday.

ELEC0306-005 05/28/2018

MEDINA (Brunswick, Chatham, Granger, Guilford, Harrisville, Hinckley, Homer, Lafayette, Medina, Montville, Sharon, Spencer, Wadsworth, Westfield & York Townships), PORTAGE (Atwater, Aurora, Brimfield, Deerfield, Franklin, Mantua, Randolph, Ravenna, Rootstown, Shalersville, Streetsboro & Suffield Townships), SUMMIT & WAYNE (Baughman, Canaan, Chester, Chippewa, Congress, Green, Milton, & Wayne Townships)

	Rates	Fringes
CABLE SPLICER	$ 36.87	16.56
ELECTRICIAN	$ 34.54	5%+18.06

ELEC0317-002 06/01/2019

GALLIA & LAWRENCE

	Rates	Fringes
CABLE SPLICER	$ 32.68	18.13
ELECTRICIAN	$ 34.35	25.70

ELEC0540-005 01/01/2020

CARROLL (Northern half, including Fox, Harrison, Rose & Washington Townhships), COLUMBIANA (Knox Township), HOLMES, MAHONING (Smith Township), STARK, TUSCARAWAS (North of Auburn, Clay, Rush & York Townships), and WAYNE (South of Baughman, Chester, Green & Wayne Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 33.71	24.22

ELEC0573-003 11/25/2019

ASHTABULA (Colebrook, Wayne, Williamsfield, Orwell & Windsor Townships), GEAUGA (Auburn, Middlefield, Parkman & Troy Townships), MAHONING (Milton Township), PORTAGE (Charlestown, Edinburg, Freedom, Hiram, Nelson, Palmyra, Paris & Windham Townships), and TRUMBULL (Except Liberty & Hubbard Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.21	19.24

ELEC0575-001 05/27/2019

ADAMS, FAYETTE, HIGHLAND, HOCKING, JACKSON (Bloomfield, Franklin, Hamilton, Jefferson, Lick, Madison, Scioto, Coal, Jackson, Liberty, Milton & Washington Townships), PICKAWAY (Deer Creek, Perry, Pickaway, Salt Creek & Wayne Townships), PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, PeePee, Perry, Seal, Camp Creek, Newton, Scioto, Sunfish, Union & Marion Townships), ROSS, SCIOTO & VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships)

	Rates	Fringes
ELECTRICIAN	$ 33.75	17.19

ELEC0648-001 09/02/2019

BUTLER and WARREN COUNTIES (Deerfield, Hamilton, Harlan, Massie, Salem, Turtle Creek, Union & Washington Townships)

	Rates	Fringes
CABLE SPLICER	$ 30.50	18.23
ELECTRICIAN	$ 30.00	19.85

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* ELEC0673-004 02/01/2020

ASHTABULA (Excluding Orwell, Colebrook, Williamsfield, Wayne & Windsor Townships), GEAUGA (Burton, Chardon, Claridon, Hambden, Huntsburg, Montville, Munson, Newbury & Thompson Townships) and LAKE COUNTIES

	Rates	Fringes
CABLE SPLICER	$ 33.81	21.47
ELECTRICIAN	$ 33.56	21.47

ELEC0683-002 05/27/2019

CHAMPAIGN, CLARK, DELAWARE, FAIRFIELD, FRANKLIN, MADISON, PICKAWAY (Circleville, Darby, Harrison, Jackson, Madison, Monroe, Muhlenberg, Scioto, Walnut & Washington Townships), and UNION COUNTIES

	Rates	Fringes
CABLE SPLICER	$ 34.50	21.20
ELECTRICIAN	$ 33.50	20.18

ELEC0688-003 12/02/2019

ASHLAND, CRAWFORD, HURON (Richmond, New Haven, Ripley & Greenwich Townships), KNOX (Liberty, Clinton, Union, Howard, Monroe, Middleberry, Morris, Wayne, Berlin, Pike, Brown & Jefferson Townships), MARION, MORROW, RICHLAND and WYANDOT (Sycamore, Crane, Eden, Pitt, Antrim & Tymochtee Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.00	18.86

ELEC0972-002 06/01/2019

ATHENS, MEIGS, MONROE, MORGAN, NOBLE, VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships), and WASHINGTON COUNITES

	Rates	Fringes
CABLE SPLICER	$ 33.80	26.65
ELECTRICIAN	$ 33.55	26.65

ELEC1105-001 05/28/2018

COSHOCTON, GUERNSEY, KNOX (Jackson, Clay, Morgan, Miller, Milford, Hilliar, Butler, Harrison, Pleasant & College Townships), LICKING, MUSKINGUM, PERRY, and TUSCARAWAS (Auburn, York, Clay, Jefferson, Rush, Oxford, Washington, Salem, Perry & Bucks Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.95	17.96

ENGI0018-003 05/01/2019

ASHTABULA, CUYAHOGA, ERIE, GEAUGA, LAKE, LORAIN, MEDINA, PORTAGE, and SUMMIT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1	$ 38.63	15.20
GROUP 2	$ 38.53	15.20
GROUP 3	$ 37.49	15.20
GROUP 4	$ 36.27	15.20
GROUP 5	$ 30.98	15.20
GROUP 6	$ 38.88	15.20
GROUP 7	$ 39.13	15.20

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker);

Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24"" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; Wheel Excavator; and Asphalt Plant Engineer (Cleveland District Only).

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48""; Bulldozer; Endloader; Horizontal Directional Drill (Over 50,000 ft lbs thrust); Hydro Milling Machine; Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24"" wide & under); Vermeer type Concrete Saw; and Maintenance Operators (Portage and Summit Counties Only).

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer (Portage and Summit Counties Only); Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4"" & over discharge); Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); Welding Machines; and Railroad Tie Inserter/Remover; Articulating/straight bed end dumps if assigned (minus $4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48"" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Forklift; Form Trencher; Hydro Hammer expect masonary; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonry Fork Lift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4"" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0018-004 05/01/2019

ADAMS, ALLEN, ASHLAND, ATHENS, AUGLAIZE, BELMONT, BROWN, BUTLER, CARROLL, CHAMPAIGN, CLARK, CLERMONT, CLINTON, COSHOCTON, CRAWFORD, DARKE, DEFIANCE, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, FULTON, GALLIA, GREENE, GUERNSEY, HAMILTON, HANCOCK, HARDIN, HARRISON, HENRY, HIGHLAND, HOCKING, HOLMES, HURON, JACKSON, JEFFERSON, KNOX, LAWRENCE, LICKING, LOGAN, LUCAS, MADISON, MARION, MEIGS, MERCER, MIAMI, MONROE, MONTGOMERY, MORGAN, MORROW, MUSKINGUM, NOBLE, OTTAWA, PAULDING, PERRY, PICKAWAY, PIKE, PREBLE, PUTNAM, RICHLAND, ROSS, SANDUSKY, SCIOTO, SENECA, SHELBY, STARK, TUSCARAWAS, UNION, VAN WERT, VINTON, WARREN, WASHINGTON, WAYNE, WILLIAMS, WOOD, and YANDOT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		

GROUP 1	$ 37.14	15.20
GROUP 2	$ 37.02	15.20
GROUP 3	$ 35.98	15.20
GROUP 4	$ 34.80	15.20
GROUP 5	$ 29.34	15.20
GROUP 6	$ 37.39	15.20
GROUP 7	$ 37.64	15.20

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker); Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24"" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; and Wheel Excavator.

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48""; Bulldozer; Endloader; Hydro Milling Machine; Horizontal Directional Drill (over 50,000 ft. lbs. thrust);Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24"" wide & under); and Vermeer type Concrete Saw.

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer; Bobcat-type and/or Skid

Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4"" & over discharge); Railroad Tie Inserter/Remover; Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); and Welding Machines; Artiaculating/straight bed end dumps if assigned (minus $4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48"" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Fork Lift; Form Trencher; Hydro Hammer expect masonary; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonary Forklift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4"" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0066-023 06/01/2017

COLUMBIANA, MAHONING & TRUMBULL COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 1 - A & B	$ 39.23	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 2 - A & B	$ 38.90	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 3 - A & B	$ 34.64	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 4 - A & B	$ 30.70	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 5 - A & B	$ 27.30	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 1 - C & D	$ 35.96	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 2 - C & D	$ 35.66	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 3 - C & D	$ 31.76	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 4 - C & D	$ 28.14	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 5 - C & D	$ 25.03	19.66
ALL OTHER WORK		
GROUP 1	$ 32.69	19.66
ALL OTHER WORK		
GROUP 2	$ 32.42	19.66
ALL OTHER WORK		
GROUP 3	$ 28.87	19.66
ALL OTHER WORK		
GROUP 4	$ 25.58	19.66
ALL OTHER WORK		
GROUP 5	$ 22.75	19.66

GROUP 1 - Rig, Pile Driver or Caisson Type; & Rig, Pile Hydraulic Unit Attached

GROUP 2 - Asphalt Heater Planer; Backfiller with Drag Attachment; Backhoe; Backhoe with Shear attached; Backhoe-Rear Pivotal Swing; Batch Plant-Central Mix Concrete; Batch Plant, Portable concrete; Berm Builder-Automatic; Boat Derrick; Boat-Tug; Boring Machine Attached to Tractor; Bullclam; Bulldozer; C.M.I. Road Builder & Similar Type; Cable Placer & Layer; Carrier-Straddle; Carryall-Scraper or Scoop; Chicago Boom; Compactor with Blade Attached; Concrete Saw (Vermeer or similar type); Concrete Spreader Finisher; Combination, Bidwell Machine; Crane; Crane-Electric Overhead; Crane-Rough Terrain; Crane-Side Boom; Crane-Truck; Crane-Tower; Derrick-Boom; Derrick-Car; Digger-Wheel (Not trencher or road widener); Double Nine; Drag Line; Dredge; Drill-Kenny or Similar Type; Easy Pour Median Barrier Machine (or similar type); Electromatic; Frankie Pile; Gradall; Grader; Gurry; Self-Propelled; Heavy Equipment Robotics Operator/Mechanic; Hoist-Monorail; Hoist-Stationary & Mobile Tractor; Hoist, 2 or 3 drum; Horizontal Directional Drill Operator; Jackall; Jumbo Machine; Kocal & Kuhlman; Land-Seagoing Vehicle; Loader, Elevating; Loader, Front End; Loader, Skid Steer; Locomotive; Mechanic/Welder; Metro Chip Harvester with Boom; Mucking Machine; Paver-Asphalt Finishing Machine; Paver-Road Concrete; Paver-Slip Form (C.M.I. or similar); Place Crete Machine with Boom; Post Driver (Carrier mounted); Power Driven Hydraulic Pump & Jack (When used in Slip Form or Lift Slab Construction); Pump Crete Machine; Regulator-Ballast; Hydraulic Power Unit not attached to Rig for Pile Drillings; Rigs-Drilling; Roto Mill or similar Full Lane (8' Wide & Over); Roto Mill or similar type (Under 8'); Shovel; Slip Form Curb Machine; Speedwing; Spikemaster; Stonecrusher; Tie Puller & Loader; Tie Tamper; Tractor-Double Boom; Tractor with Attachments; Truck-Boom; Truck-Tire; Trench Machine; Tunnel Machine (Mark 21 Java or similar); & Whirley (or similar type)

GROUP 3 - Asphalt Plant; Bending Machine (Pipeline or similar type); Boring machine, Motor Driven; Chip Harvester without Boom; Cleaning Machine, Pipeline Type; Coating Machine, Pipeline Type; Compactor; Concrete Belt Placer; Concrete Finisher; Concrete Planer or Asphalt; Concrete Spreader; Elevator; Fork Lift (Home building only); Fork lift & Lulls; Fork Lift Walk Behind (Hoisting over 1 buck high); Form Line Machine; Grease Truck operator; Grout Pump; Gunnite Machine; Horizontal Directional Drill Locator; Single Drum Hoist with or without Tower; Huck Bolting Machine; Hydraulic Scaffold (Hoisting building materials); Paving Breaker (Self-propelled or Ridden); Pipe Dream; Pot Fireperson (Power Agitated); Refrigeration Plant; Road Widener; Roller; Sasgen Derrick; Seeding Machine; Soil Stabilizer (Pump type); Spray Cure Machine, Self-Propelled; Straw Blower Machine; Sub-Grader; Tube Finisher or Broom C.M.I. or similar type; & Tugger Hoist

GROUP 4 - Air Curtain Destructor & Similar Type; Batch Plant-Job Related; Boiler Operator; Compressor; Conveyor; Curb Builder, self-propelled; Drill Wagon; Generator Set; Generator-Steam; Heater-Portable Power; Hydraulic Manipulator Crane; Jack-Hydraulic Power driven; Jack-Hydraulic (Railroad); Ladavator; Minor Machine Operator; Mixer-Concrete; Mulching Machine; Pin Puller; Power Broom; Pulverizer; Pump; Road Finishing Machine (Pull Type); Saw-Concrete-Self-Propelled (Highway Work); Signal Person; Spray Cure Machine-Motor Powered; Stump Cutter; Tractor; Trencher Form; Water Blaster; Steam Jenny; Syphon; Vibrator-Gasoline; & Welding Machine

GROUP 5 - Brakeperson; Fireperson; & Oiler

IRON0017-002 05/01/2019

ASHTABULA (North of Route 6, starting at the Geauga County Line, proceeding east to State Route 45), CUYAHOGA, ERIE (Eastern 2/3), GEAUGA, HURON (East of a line drawn from the north border through Monroeville & Willard), LAKE, LORAIN, MEDINA (North of Old Rte. #224), PORTAGE (West of a line from Middlefield to Shalersville to Deerfield), and SUMMIT (North of Old Rte. #224, including city limits of Barberton) COUNTIES

	Rates	Fringes
IRONWORKER		
Ornamental, Reinforcing, & Structural	$ 34.93	22.00

IRON0017-010 05/01/2019

ASHTABULA (Eastern part from Lake Erie on the north to route #322 on the south to include Conneaut, Kingsville, Sheffield,

Denmark, Dorset, Cherry Valley, Wayne, Monroe, Pierpont, Richmond, Andover & Williamsfield Townships)

	Rates	Fringes
IRONWORKER		
Structural, including metal building erection & Reinforcing	$ 34.93	22.00

IRON0044-001 06/01/2018

ADAMS (Western Part), BROWN, BUTLER (Southern Part), CLERMONT, CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) and WARREN (South of a line drawn from Blanchester through Morrow to the west county line) COUNTIES

	Rates	Fringes
IRONWORKER, REINFORCING		
Beyond 30-mile radius of Hamilton County Courthouse	$ 28.67	21.20
Up to & including 30-mile radius of Hamilton County Courthouse	$ 27.60	20.70

IRON0044-002 06/01/2019

CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) & WARREN (South of a line drawn from Blanchester through Morrow to the west county line)

	Rates	Fringes
IRONWORKER		
Fence Erector	$ 28.00	21.20
Ornamental; Structural	$ 29.47	21.20

IRON0055-003 07/01/2019

CRAWFORD (Area Between lines drawn from where Hwy #598 & #30

meet through N. Liberty to the northern border & from said Hwy junction point due west to the border), DEFIANCE (S. of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), ERIE (Western 1/3), FULTON, HANCOCK, HARDIN (North of a line drawn from Maysville to a point 4 miles south of the northern line on the eastern line), HENRY, HURON (West of a line drawn from the northern border through Monroeville & Willard), LUCAS, OTTAWA, PUTNAM (East of a line drawn from the northern border down through Miller City to where #696 meets the southern border), SANDUSKY, SENECA, WILLIAMS (East of a line drawn from Pioneer through Stryker to the southern border), WOOD & WYANDOT (North of Rte. #30)

	Rates	Fringes
IRONWORKER		
Fence Erector	$ 21.30	20.92
Flat Road Mesh	$ 29.77	21.30
Tunnels & Caissons Under Pressure	$ 29.77	21.30
All Other Work	$ 30.38	24.40

IRON0147-002 06/01/2015

ALLEN (Northern half), DEFIANCE (Northern part, excluding south of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), MERCER (Northern half), PAULDING, PUTNAM (Western part, excluding east of a line drawn from the northern border down through Miller City to where #696 meets the southern border), VAN WERT, and WILLIAMS (Western part, excluding east of a line drawn from Pioneer through Stryker to the southern border) COUNTIES

	Rates	Fringes
IRONWORKER	$ 25.39	20.64

IRON0172-002 06/01/2019

CHAMPAIGN (Eastern one-third), CLARK (Eastern one-fourth), COSHOCTON (West of a line beginning at the northwestern county line going through Walhonding & Tunnel Hill to the southern county line), CRAWFORD (South of Rte. #30), DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, HARDIN (Excluding a line drawn from Roundhead to Maysville), HIGHLAND (Eastern one-fifth), HOCKING, JACKSON (Northern half), KNOX, LICKING, LOGAN (Eastern one-third), MADISON, MARION, MORROW, MUSKINGUM (West of a line

starting at Adams Mill going to Adamsville & going from Adamsville through Blue Rock to the southern border), PERRY, PICKAWAY, PIKE (Northern half), ROSS, UNION, VINTON and WYANDOT (South of Rte. #30) COUNTIES

	Rates	Fringes
IRONWORKER	$ 30.00	20.70

IRON0207-004 06/01/2019

ASHTABULA (Southern part starting at the Geauga County line), COLUMBIANA (E. of a line from Damascus to Highlandtown), MAHONING (N. of Old Route #224), PORTAGE (E. of a line from Middlefield to Shalersville to Deerfield) & TRUMBULL

	Rates	Fringes
IRONWORKER		
Layout; Sheeter	$ 30.72	25.15
Ornamental; Reinforcing; Structural	$ 28.06	24.70
Ornamental; Reinforcing	$ 29.72	25.18

IRON0290-002 06/01/2019

ALLEN (Southern half), AUGLAIZE, BUTLER (North of a line drawn from east to the west county line going through Oxford, Darrtown & Woodsdale), CHAMPAIGN (Excluding east of a line drawn from Catawla to the point where #68 intersects the northern county line), CLARK (Western two-thirds), CLINTON (Excluding south of a line drawn from Blanchester to Lynchburg), DARKE, GREENE, HIGHLAND (Inside lines drawn from Marshall to Lynchburg & from the northern county line through East Monroe to Marshall), LOGAN (West of a line drawn from West Liberty to where the northern county line meets the western county line of Hardin), MERCER (Southern half), MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN (Excluding south of a line drawn from Blanchester through Morrow to the western county line) COUNTIES

	Rates	Fringes
IRONWORKER	$ 29.23	33.35

IRON0549-003 12/01/2018

BELMONT, GUERNSEY, HARRISON, JEFFERSON, MONROE & MUSKINGUM (Excluding portion west of a line starting at Adams Mill going to Adamsville and going from Adamsville through Blue Rock to the south border)

	Rates	Fringes
IRONWORKER	$ 33.34	20.81

IRON0550-004 05/01/2019

ASHLAND, CARROLL, COLUMBIANA (W. of a line from Damascus to Highlandtown), COSHOCTON (E. of a line beginning at NW Co. line going through Walhonding & Tunnel Hill to the South Co. line), HOLMES, HURON (S. of Old Rte. #224), MAHONING (S. of Old Rte. #224), MEDINA (S. of Old Rte. #224), PORTAGE (S. of Old Rte. #224), RICHLAND, STARK, SUMMIT (S. of Old Rte. #224, Excluding city limits of Barberton), TUSCARAWAS, & WAYNE

	Rates	Fringes
Ironworkers:Structural, Ornamental and Reinforcing	$ 28.90	19.87

IRON0769-004 06/01/2019

ADAMS (Eastern Half), GALLIA, JACKSON (Southern Half), LAWRENCE & SCIOTO

	Rates	Fringes
IRONWORKER	$ 32.00	25.95

IRON0787-003 12/01/2019

ATHENS, MEIGS, MORGAN, NOBLE, and WASHINGTON COUNTIES

	Rates	Fringes
IRONWORKER	$ 30.18	22.75

LABO0265-008 05/01/2018

	Rates	Fringes
LABORER		
ASHTABULA, ERIE, HURON,		

LORAIN, LUCAS, MAHONING,
MEDINA, OTTAWA, PORTAGE,
SANDUSKY, STARK, SUMMIT,
TRUMBULL & WOOD COUNTIES
GROUP 1.....$ 31.05 10.95
GROUP 2.....$ 31.22 10.95
GROUP 3.....$ 31.55 10.95
GROUP 4.....$ 32.00 10.95
CUYAHOGA AND GEAUGA
COUNTIES ONLY: SEWAGE
PLANTS, WASTE PLANTS,
WATER TREATMENT
FACILITIES, PUMPING
STATIONS, & ETHANOL PLANTS
CONSTRUCTION.....$ 33.66 10.95
CUYAHOGA, GEAUGA & LAKE
COUNTIES
GROUP 1.....$ 32.28 10.95
GROUP 2.....$ 32.45 10.95
GROUP 3.....$ 32.78 10.95
GROUP 4.....$ 33.23 10.95
REMAINING COUNTIES OF OHIO
GROUP 1.....$ 30.62 10.95
GROUP 2.....$ 30.79 10.95
GROUP 3.....$ 31.12 10.95
GROUP 4.....$ 31.57 10.95

LABORER CLASSIFICATIONS

GROUP 1 - Asphalt Laborer; Carpenter Tender; Concrete Curing Applicator; Dump Man (Batch Truck); Guardrail and Fence Installer; Joint Setter; Laborer (Construction); Landscape Laborer; Mesh Handlers & Placer; Right-of-way Laborer; Riprap Laborer & Grouter; Scaffold Erector; Seal Coating; Surface Treatment or Road Mix Laborer; Sign Installer; Slurry Seal; Utility Man; Bridge Man; Handyman; Waterproofing Laborer; Flagperson; Hazardous Waste (level D); Diver Tender; Zone Person & Traffic Control

GROUP 2 - Asphalt Raker; Concrete Puddler; Kettle Man Pipeline); Machine Driven Tools (Gas, Electric, Air); Mason Tender; Brick Paver; Mortar Mixer; Power Buggy or Power Wheelbarrow; Paint Striper; Sheeting & Shoring Man; Surface Grinder Man; Plastic Fusing Machine Operator; Pug Mill Operator; & Vacuum Devices (wet or dry); Rodding Machine Operator; Diver; Screwman or Paver; Screed Person; Water Blast, Hand Held Wand; Pumps 4"" & Under (Gas, Air or Electric) & Hazardous Waste (level C); Air Track and Wagon Drill; Bottom Person; Cofferdam (below 25 ft. deep); Concrete Saw Person; Cutting with Burning Torch; Form

Setter; Hand Spiker (Railroad); Pipelayer; Tunnel Laborer (without air) & Caisson; Underground Person (working in Sewer and Waterline, Cleaning, Repairing & Reconditioning); Sandblaster Nozzle Person; & Hazardous Waste (level B)

GROUP 3 - Blaster; Mucker; Powder Person; Top Lander; Wrencher (Mechanical Joints & Utility Pipeline); Yarner; Hazardous Waste (level A); Concrete Specialist; Concrete Crew in Tunnels (With Air-pressurized - $1.00 premium); Curb Setter & Cutter; Grade Checker; Utility Pipeline Tapper; Waterline; and Caulker

GROUP 4 - Miner (With Air-pressurized - $1.00 premium); & Gunite Nozzle Person

TUNNEL LABORER WITH AIR-PRESSURIZED ADD $1.00 TO BASE RATE

SIGNAL PERSON WILL RECEIVE THE RATE EQUAL TO THE RATE PAID THE LABORER CLASSIFICATION FOR WHICH HE OR SHE IS SIGNALING.

PAIN0006-002 05/01/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN, PORTAGE (N. of the East-West Turnpike) & SUMMIT (N. of the East-West Turnpike)

	Rates	Fringes
PAINTER		
COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS		
GROUP 1	$ 27.90	16.16
GROUP 2	$ 28.30	16.16
GROUP 3	$ 28.60	16.16
GROUP 4	$ 34.16	16.16
COMMERCIAL REPAINT		
GROUP 1	$ 26.40	16.16
GROUP 2	$ 26.80	16.16
GROUP 3	$ 27.10	16.16

PAINTER CLASSIFICATIONS - COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting; Closed Steel Above 55 feet; Bridges & Open Structural Steel; Tanks - Water Towers; Bridge

Painters; Bridge Riggers; Containment Builders

GROUP 4 - Bridge Blaster

PAINTER CLASSIFICATIONS - COMMERCIAL REPAINT

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting

PAIN0007-002 07/01/2019

FULTON, HENRY, LUCAS, OTTAWA (Excluding Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genova) & WOOD

	Rates	Fringes
PAINTER		
NEW COMMERCIAL WORK		
GROUP 1	$ 27.64	17.79
GROUP 2	$ 27.39	17.79
GROUP 3	$ 27.39	17.79
GROUP 4	$ 27.39	17.79
GROUP 5	$ 27.39	17.79
GROUP 6	$ 27.39	17.79
GROUP 7	$ 27.39	17.79
GROUP 8	$ 27.39	17.79
GROUP 9	$ 27.39	17.79

REPAINT IS 90% OF JR

PAINTER CLASSIFICATIONS

GROUP 1 - Brush; Spray & Sandblasting Pot Tender

GROUP 2 - Refineries & Refinery Tanks; Surfaces 30 ft. or over where material is applied to or labor performed on above ground level (exterior), floor level (interior)

GROUP 3 - Swing Stage & Chair

GROUP 4 - Lead Abatement

GROUP 5 - All Methods of Spray

GROUP 6 - Solvent-Based Catalized Epoxy Materials of 2 or More Component Materials, to include Solvent-Based Conversion Varnish (excluding water based)

GROUP 7 - Spray Solvent Based Material; Sand & Abrasive Blasting

GROUP 8 - Towers; Tanks; Bridges; Stacks Over 30 Feet

GROUP 9 - Epoxy Spray (excluding water based)

PAIN0012-008 05/01/2019

BUTLER COUNTY

	Rates	Fringes
PAINTER		
GROUP 1	$ 21.95	10.20
GROUP 2	$ 25.30	10.20
GROUP 3	$ 25.80	10.20
GROUP 4	$ 26.05	10.20
GROUP 5	$ 26.30	10.20

PAINTER CLASSIFICATIONS

GROUP 1: Bridge Equipment Tender; Bridge/Containment Builder

GROUP 2: Brush & Roller

GROUP 3: Spray

GROUP 4: Sandblasting; & Waterblasting

GROUP 5: Elevated Tanks; Steeplejack Work; Bridge; & Lead Abatement

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PAIN0012-010 05/01/2019

BROWN, CLERMONT, CLINTON, HAMILTON & WARREN

	Rates	Fringes
PAINTER		
HEAVY & HIGHWAY BRIDGES-		
GUARDRAILS-LIGHTPOLES-		

STRIPING
Bridge Equipment Tender
and Containment Builder....$ 21.95 10.20
Bridges when highest
point of clearance is 60
feet or more; & Lead
Abatement Projects.....$ 26.30 10.20
Brush & Roller.....$ 25.30 10.20
Sandblasting & Hopper
Tender; Water Blasting.....$ 26.05 10.20
Spray.....$ 25.80 10.20

PAIN0093-001 12/01/2018

ATHENS, GUERNSEY, HOCKING, MONROE, MORGAN, NOBLE and WASHINGTON COUNTIES

	Rates	Fringes
PAINTER		
Bridges; Locks; Dams; Tension Towers; & Energized Substations	$ 34.04	18.50
Power Generating Facilities	$ 30.89	18.50

PAIN0249-002 05/01/2019

CLARK, DARKE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
PAINTER		
GROUP 1 - Brush & Roller	$ 23.67	11.50
GROUP 2 - Swing, Scaffold Bridges; Structural Steel; Open Acid Tank; High Tension Electrical Equipment; & Hot Pipes	$ 23.67	11.50
GROUP 3 - Spray; Sandblast; Steamclean; Lead Abatement	$ 24.42	11.50
GROUP 4 - Steeplejack Work	$ 24.62	11.50
GROUP 5 - Coal Tar	$ 25.17	11.50
GROUP 6 - Bridge Equipment Tender & or Containment Builder	$ 32.38	11.50
GROUP 7 - Tanks, Stacks & Towers	$ 27.31	11.50

GROUP 8 - Bridge Blaster, Rigger	$ 35.38	11.50

PAIN0356-002 09/01/2009

KNOX, LICKING, MUSKINGUM, and PERRY

	Rates	Fringes
PAINTER		
Bridge Equipment Tenders and Containment Builders	$ 27.93	7.25
Bridges; Blasters; andRiggers	$ 34.60	7.25
Brush and Roller	$ 20.93	7.25
Sandblasting; Steam Cleaning; Waterblasting; and Hazardous Work	$ 25.82	7.25
Spray	$ 21.40	7.25
Structural Steel and Swing Stage	$ 25.42	7.25
Tanks; Stacks; and Towers	$ 28.63	7.25

PAIN0438-002 12/01/2018

BELMONT, HARRISON and JEFFERSON COUNTIES

	Rates	Fringes
PAINTER		
Bridges, Locks, Dams, Tension Towers & Energized Substations	$ 32.80	17.68
Power Generating Facilities	$ 29.65	17.68

PAIN0476-001 06/01/2019

COLUMBIANA, MAHONING, and TRUMBULL COUNITES

	Rates	Fringes
PAINTER		
GROUP 1	$ 25.82	16.58
GROUP 2	$ 32.45	16.58
GROUP 3	$ 26.03	16.58
GROUP 4	$ 26.47	16.58
GROUP 5	$ 26.47	16.58
GROUP 6	$ 26.72	16.58
GROUP 7	$ 27.82	16.58

PAINTER CLASSIFICATIONS:

GROUP 1: Painters, Brush & Roller

GROUP 2: Bridges

GROUP 3: Structural Steel

GROUP 4: Spray, Except Bar Joist/Deck

GROUP 5: Epoxy/Mastic; Spray- Bar Joist/Deck; Working Above 50 Feet; and Swingstages

GROUP 6: Tanks; Sandblasting

GROUP 7: Towers; Stacks

PAIN0555-002 06/01/2019

ADAMS, HIGHLAND, JACKSON, PIKE & SCIOTO

	Rates	Fringes
PAINTER		
GROUP 1	$ 31.04	16.31
GROUP 2	$ 32.50	16.31
GROUP 3	$ 33.96	16.31
GROUP 4	$ 36.82	16.31

PAINTER CLASSIFICATIONS

GROUP 1 - Containment Builder

GROUP 2 - Brush; Roller; Power Tools, Under 40 feet

GROUP 3 - Sand Blasting; Spray; Steam Cleaning; Pressure Washing; Epoxy & Two Component Materials; Lead Abatement; Hazardous Waste; Toxic Materials; Bulk & Storage Tanks of 25,000 Gallon Capacity or More; Elevated Tanks

GROUP 4 - Stacks; Bridges

PAIN0639-001 05/01/2011

	Rates	Fringes
Sign Painter & Erector	$ 20.61	3.50+a+b+c

FOOTNOTES: a. 7 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; Christmas Day & 1 Floating Day
b. Vacation Pay: After 1 year's service - 5 days' paid vacation; After 2, but less than 10 years' service - 10 days' paid vacation; After 10, but less than 20 years' service - 15 days' paid vacation; After 20 years' service - 20 days' paid vacation
c. Funeral leave up to 3 days maximum paid leave for death of mother, father, brother, sister, spouse, child, mother-in-law, father-in-law, grandparent and inlaw provided employee attends funeral

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PAIN0788-002 06/01/2019

ASHLAND, CRAWFORD, ERIE, HANCOCK, HURON, MARION, MORROW, OTTAWA (Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genoa), RICHLAND, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
PAINTER		
Brush & Roller	$ 24.66	14.05
Structural Steel	$ 26.26	14.05

WINTER REPAINT: Between December 1 to March 31 - 90%JR

$.50 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

While working swingstage, boatswain chair, needle beam and horizontal cable. While operating sprayguns, sandblasting, cobblasting and high pressure waterblasting (4000psi).

$1.00 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

For the application of catalized epoxy, including latex epoxy that is deemed hazardous, lead abatement, or for work or material where special precautions beyond normal work duties must be taken. For working on stacks, tanks, and towers over 40 feet in height.

PAIN0813-005 12/01/2008

GALLIA, LAWRENCE, MEIGS & VINTON

	Rates	Fringes
PAINTER		
Base Rate	$ 24.83	10.00
Bridges, Locks, Dams & Tension Towers	$ 27.83	10.00

PAIN0841-001 06/01/2018

MEDINA, PORTAGE (South of and including Ohio Turnpike), and SUMMIT (South of and including Ohio Turnpike) COUNTIES

	Rates	Fringes
Painters:		
GROUP 1	$ 25.75	14.35
GROUP 2	$ 26.40	14.35
GROUP 3	$ 26.50	14.35
GROUP 4	$ 26.60	14.35
GROUP 5	$ 27.00	14.35
GROUP 6	$ 39.20	11.75
GROUP 7	$ 27.00	14.35

PAINTER CLASSIFICATIONS:

GROUP 1 - Brush, Roller & Paperhanger

GROUP 2 - Epoxy Application

GROUP 3 - Swing Scaffold, Bosum Chair, & Window Jack

GROUP 4 - Spray Gun Operator of Any & All Coatings

GROUP 5 - Sandblast, Painting of Standpipes, etc. from Scaffolds, Bridge Work and/or Open Structural Steel, Standpipes and/or Water Towers

GROUP 6 - Public & Commerce Transportation, Steel or Galvanized, Bridges, Tunnels & Related Support Items (concrete)

GROUP 7 - Synthetic Exterior, Drywall Finisher and/or Taper, Drywall Finisher and Follow-up Man Using Automatic Tools

PAIN0841-002 06/01/2018

CARROLL, COSHOCTON, HOLMES, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
PAINTER		
Bridges; Towers, Poles & Stacks; Sandblasting Steel; Structural Steel & Metalizing	$ 22.78	13.63
Brush & Roller	$ 21.77	13.63
Spray; Tank Interior & Exterior	$ 22.60	13.63

PAIN1020-002 04/01/2019

ALLEN, AUGLAIZE, CHAMPAIGN, DEFIANCE, HARDIN, LOGAN, MERCER, PAULDING, PUTNAM, SHELBY, VAN WERT, and WILLIAMS COUNTIES

	Rates	Fringes
PAINTER		
Brush & Roller	$ 24.57	15.03
Drywall Finishing & Taping	$ 23.27	15.03
Lead Abatement	$ 26.32	15.03
Spray, Sandblasting Pressure Cleaning, & Refinery	$ 25.32	15.03
Swing Stage, Chair, Spiders, & Cherry Pickers	$ 24.82	15.03
Wallcoverings	$ 22.17	15.03

All surfaces 40 ft. or over where material is applied to or labor performed on, above ground level (exterior), floor level (interior) - $.50 premium

Applying Coal Tar Products - $1.00 premium

PAIN1275-002 05/01/2019

DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, MADISON, PICKAWAY, ROSS & UNION

	Rates	Fringes
PAINTER		
Bridges	$ 34.24	14.20
Brush; Roller	$ 24.76	14.20
Sandblasting; Steamcleaning; Waterblasting (3500 PSI or Over)& Hazardous Work	$ 25.46	14.20
Spray	$ 25.26	14.20
Stacks; Tanks; & Towers	$ 28.27	14.20
Structural Steel & Swing Stage	$ 25.06	14.20

PLAS0109-001 05/01/2018

MEDINA, PORTAGE, STARK, and SUMMIT COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0109-003 05/01/2018

CARROLL, HOLMES, TUSCARAWAS, and WAYNE COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLAS0132-002 05/01/2018

BROWN, BUTLER, CLERMONT, HAMILTON, HIGHLAND, WARREN COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0404-002 05/01/2018

ASHTABULA, CUYAHOGA, GEAUGA, AND LAKE COUNTIES

	Rates	Fringes
PLASTERER	$ 29.63	17.11

PLAS0404-003 05/01/2018

LORAIN COUNTY

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0526-022 05/01/2018

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0526-023 05/01/2018

BELMONT, HARRISON, and JEFFERSON COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLAS0886-001 05/01/2018

FULTON, HANCOCK, HENRY, LUCAS, PUTNAM, and WOOD COUNTIES

	Rates	Fringes
PLASTERER	$ 29.63	17.11

PLAS0886-003 05/01/2018

DEFIANCE, ERIE, HURON, OTTAWA, PAULDING, SANDUSKY, and SENECA COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0886-004 05/01/2018

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, and VAN WERT COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLUM0042-002 07/01/2018

ASHLAND, CRAWFORD, ERIE, HURON, KNOX, LORAIN, MORROW, RICHLAND & WYANDOT

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 34.20	22.07

PLUM0050-002 07/01/2019

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 42.00	26.73

PLUM0055-003 04/29/2019

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, MEDINA (N. of Rte. #18 & Smith Road) & SUMMIT (N. of Rte. #303, including the corporate limits of the city of Hudson)

	Rates	Fringes
PLUMBER	$ 36.55	26.74

PLUM0083-001 07/01/2017

BELMONT & MONROE (North of Rte. #78)

	Rates	Fringes
Plumber and Steamfitter	$ 32.16	31.51

PLUM0094-002 05/01/2019

CARROLL (Northen Half), STARK, and WAYNE COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 35.78	20.14

PLUM0120-002 04/30/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN (the C.E.I. Power House in Avon Lake), MEDINA (N. of Rte. #18) & SUMMIT (N. of #303)

	Rates	Fringes
PIPEFITTER	$ 37.67	22.42

PLUM0162-002 01/01/2020

CHAMPAIGN, CLARK, CLINTON, DARKE, FAYETTE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 31.25	25.52

PLUM0168-002 06/01/2019

MEIGS, MONROE (South of Rte. #78), MORGAN (South of Rte. #78) & WASHINGTON

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 35.32	31.63

PLUM0189-002 06/01/2019

DELAWARE, FAIRFIELD, FRANKLIN, HOCKING, LICKING, MADISON, MARION, PERRY, PICKAWAY, ROSS & UNION

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 38.45	16.98

PLUM0219-002 05/31/2018

MEDINA (Rte. #18 from eastern edge of Medina Co., west to eastern corporate limits of the city of Medina, & on the county road from the west corporate limits of Medina running due west to and through community of Risley to the western edge of Medina County - All territory south of this line), PORTAGE, and SUMMIT (S. of Rte. #303) COUNTIES

	Rates	Fringes
Plumber and Steamfitter	$ 37.02	23.79

PLUM0392-002 06/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON & WARREN

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 32.81	21.27

PLUM0396-001 06/01/2019

COLUMBIANA (Excluding Washington & Yellow Creek Townships & Liverpool Twp. - Secs. 35 & 36 - West of County Road #427), MAHONING and TRUMBULL COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 34.00	25.46

PLUM0495-002 06/01/2018

CARROLL (Rose, Monroe, Union, Lee, Orange, Perry & Loudon Townships), COLUMBIANA (Washington & Yellow Creek Townships & Liverpool Township, Secs. 35 & 36, West of County Rd. #427), COSHOCTON, GUERNSEY, HARRISON, HOLMES, JEFFERSON, MORGAN (South to State Rte. #78 & from McConnelsville west on State Rte. #37 to the Perry County line), MUSKINGUM, NOBLE, and TUSCARAWAS COUNTIES

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 38.24	23.09

PLUM0577-002 06/01/2019

ADAMS, ATHENS, GALLIA, HIGHLAND, JACKSON, LAWRENCE, PIKE, SCIOTO & VINTON

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 34.90	24.11

PLUM0776-002 08/01/2019

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY and VAN WERT COUNTIES

	Rates	Fringes

Plumber, Pipefitter, Steamfitter	$ 36.64	24.73

TEAM0377-003 05/01/2019

STATEWIDE, EXCEPT CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 28.04	15.70
GROUP 2	$ 28.46	15.70

TRUCK DRIVER CLASSIFICATIONS

GROUP 1 - Asphalt Distributor; Batch; 4- Wheel Service; 4-Wheel Dump; Oil Distributor & Tandem

GROUP 2 - Tractor-Trailer Combination: Fuel; Pole Trailer; Ready Mix; Semi-Tractor; & Asphalt Oil Spraybar Man When Operated From Cab; 5 Axles & Over; Belly Dump; End Dump; Articulated Dump; Heavy Duty Equipment; Low Boy; & Truck Mechanic

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TEAM0436-002 05/01/2019

CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 28.40	16.95
GROUP 2	$ 28.90	16.95

GROUP 1: Straight & Dump, Straight Fuel

GROUP 2: Semi Fuel, Semi Tractor, Euclids, Darts, Tank, Asphalt Spreaders, Low Boys, Carry-All, Tourna-Rockers, Hi-Lifts, Extra Long Trailers, Semi-Pole Trailers, Double Hook-Up Tractor Trailers including Team Track & Railroad Siding, Semi-Tractor & Tri-Axle Trailer, Tandem Tractor & Tandem Trailer, Tag Along Trailer, Expandable Trailer or Towing Requiring Road Permits, Ready-Mix (Agitator or Non-Agitator), Bulk Concrete Driver, Dry Batch Truck, Articulated End Dump

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WELDERS - Receive rate prescribed for craft performing

operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number

where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board

U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

SECTION 40 9443

PLANT CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

B. Related Sections: The following sections contain requirements that relate to this section.
1. Division 26 Section “Basic Electrical Requirements”.
2. Division 26 Section “Basic Electrical Materials”.
3. Division 26 Section “Signal and Communication Cables”.
4. Division 26 Section “Wires, Cables, and Connectors”.
5. Division 40 Section “Instrumentation – General”.
6. Division 40 Section “Control Panels”.

1.2 DESCRIPTION OF WORK

A. General: Provide all labor, tools, equipment, and materials necessary for a complete and operational Plant Control System in accordance with the plans and as specified herein.

B. Contractor shall furnish all labor, materials, and components, and shall provide all design, assembly, testing, and start-up services required to provide a complete and operational programmable controller system (referred to herein as PLC) as specified and shown on the Drawings. The system includes, but is not necessarily limited to the following:
1. Processor modules.
2. Communication equipment.
3. Input/output (I/O) modules.
4. Operator interface equipment.
5. Mounting racks.
6. Power supplies.
7. Programming equipment.
8. Software.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of the National Electrical Code (NEC) and all other applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
1. National Electrical Manufacturers Association (NEMA).
2. Institute of Electrical and Electronic Engineers (IEEE).
3. American National Standards Institute (ANSI).
4. National Fire Protection Association (NFPA).
5. Underwriters' Laboratories (UL).
6. International Society for Measurement and Control (ISA).

C. Qualifications
   1. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of programmable logic controllers (PLCs) whose products have been in satisfactory use in similar service for not less than 5 years.
   2. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with materials and equipment similar to items specified herein.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data for all components.

B. Materials List: Submit a bill of materials listing quantities, manufacturer's name, and catalog numbers.

C. Wiring Diagrams: Submit wiring diagrams showing all connections for all equipment furnished under this section. Wire, terminal, and component labeling shall follow established facility conventions where applicable.

D. System Hardware and Software Documents: Furnish a system block diagram, I/O drawings, and control strategy descriptions. Turn over all factory software documentation and manuals to the Engineer after completion of field testing.

E. Dimensional Drawings: Furnish dimensional drawings for each piece of equipment to be provided.

F. Program Documentation: Submit annotated printouts of all PLC and Human Machine Interface (HMI) programs. Provide copies of all PLC and HMI programs on a flash drive.

G. Manufacturer's Data Sheet: Provide manufacturer's data sheet on all equipment including model numbers, serial numbers, ranges, scales, and a detail of each component.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Store the items furnished under this section in a manner that meets the requirements of the manufacturer until they can be installed. Use all means necessary to protect the material of this section before, during, and after installation, and to protect the installed work and materials of all other trades.

1.6 DEFINITIONS

A. Training Day: A training day is defined as 8 hours of classroom and hands-on instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday.

1.7 SCADA ALLOWANCE

A. The Contractor shall include in the bid an allowance for the purchase of computers, accessories, peripherals, and/or furniture for the Owner. These components shall be provided by the System Integrator. The Owner shall be able to select the computers, accessories, peripherals, and/or furniture during the shop drawing review process with technical input from the System Integrator.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

PART 2 - PRODUCTS

2.1 SCADA SYSTEM

A. Programmable Logic Controller (PLC) Components:
   1. Rack Mounted:
      a. Processor Module: 1756-L81E
      b. Digital Input Module: 1756-IA16I
      c. Digital Output Module: 1756-OW16I
      d. Analog Input Module: 1756-IF8I
      e. Analog Output Module: 1756-OF8I
      f. Communication Module: 1756-EN2T
      g. Power Supply: 1756-PA75/B
      h. Chassis: 1756-A17
   2. Protocol Gateway:
      a. Model as required for native protocol to Ethernet/IP conversion for quantity of connected devices.
      b. DIN Rail mounted
   3. Manufacturers:
      a. All components shall be manufactured by Allen-Bradley or an Encompass Partner.

B. Operator Interface Terminal (OIT):
   1. Features:
      a. Touch screen flat display
      b. Color TFT LCD
      c. 18-bit color graphics
      d. Size: 15” diagonal nominal, unless otherwise noted
      e. Resolution: 1024x768, minimum
      f. Communications: Ethernet/IP, USB
      g. SD card slot
      h. NEMA 4X
      i. Real-time battery backed clock
      j. Memory: 512 MB RAM and 512 MB user storage
      k. Input Power: 120VAC
   2. Manufacturers:
      a. Allen-Bradley, PanelView Plus 7 Performance

PART 3 - EXECUTION

3.1 CUSTOM PROGRAMMING

A. Custom Programming of all vendor provided control panels, including their PLCs and OITs, shall be provided by that vendor under the applicable specification section of the associated equipment.
   1. Provide database spreadsheets for peer-to-peer communication coordination between other onsite PLCs that need to share data.
   2. Provide database spreadsheets for Plant HMI/SCADA communication coordination.
   3. Provide annotated copies of all PLC programs.
   4. Provide an electronic copy of all PLC and OIT programming files for the Owner on a flash drive. Format shall be as required to reload into PLC memory. Logic version shall be the final program after all equipment has been installed and commissioned and Operational Demonstration is complete and successful to the Owner’s approval.

B. Custom Programming of non-vendor provided control panels, including their PLCs and OITs, will be provided by the Owner.

C. Custom Programming of plant's existing HMI/SCADA will be provided by the Owner.

D. Variable Frequency Drives
   1. Provide programming for all VFDs connected to the network.
   2. Read and display the contents of a minimum of eight registers in each VFD.
   3. Coordinate with the Owner prior to the start of programming to select the register to be displayed.

E. Graphic Screens
   1. Submit all graphic screens for Owner review and comment when sixty percent complete.
   2. Provide navigation controls on all screens to allow movement between screens.
   3. Conform to NFPA 79, Industrial Machinery on colors for indicators and controls.
   4. Conform to Owner standards for colors of process equipment and piping.
   5. Utilize industry standard symbols or graphically realistic drawings for process equipment.
   6. Provide a separate screen for each group of process equipment.
   7. Group related screens in a logical manner such as by building, plant flow, liquid stream/solids stream, etc.
   8. At a minimum, provide the following screens:
      a. Plant Overview
      b. NF Building Overview
      c. NF Feed Pumps Overview
      d. NF Skids Overview
      e. Corrosion Inhibitor System Overview
      f. Sodium Hydroxide System Overview
      g. Antiscalant System Overview
      h. NF Feed Pump Control Graphics
      i. Corrosion Inhibitor Chemical Equipment Control Graphics
      j. Corrosion Inhibitor Chemical Feed Control Graphic
      k. Sodium Hydroxide Chemical Equipment Control Graphics
      l. Sodium Hydroxide Chemical Feed Control Graphic
      m. Antiscalant Chemical Equipment Control Graphics
      n. Antiscalant Chemical Feed Control Graphic
      o. Sodium Hypochlorite System Overview
      p. Fluoride System Overview
      q. Sodium Hypochlorite Chemical Equipment Control Graphics
      r. Sodium Hypochlorite Chemical Feed Control Graphic
      s. Fluoride Chemical Equipment Control Graphics
      t. Fluoride Chemical Feed Control Graphic
      u. Electrical Service Overview
      v. Alarm Summary Screens
      w. Equipment Runtimes (with resets) Screen
      x. Totalizers Screen
      y. (10) Analog Signal Trending Screens – Owner Directed
      z. (10) Overview/Control Screens – Owner Directed

F. Global Programmed Control Strategies
   1. Meet with Plant Personnel before start of programming to determin:

a. Time of day for resetting of daily totalizers
b. Security Levels for all screens
c. The master PCS clock and approach to sync network devices

2. Display all alarms at the HMI.
3. Provide means to acknowledge all alarms at the HMI.
4. Provide alarms for PLC failure and network failure.
5. Totalize the number of starts for all process equipment and display on the plant HMI.
6. All process setpoints displayed on HMI screens and read back for confirmation.
7. All process setpoints adjustable from the HMI screens with correct security level.
8. Perform a runtime calculation for all process equipment at PLC and display at the HMI.
9. Display rate, total, and daily total for all process flows at the HMI.
10. Display all process levels at the HMI.
11. Store average daily flow rates and peak hourly flow rates of all flow meters one year or more at SCADA.
12. One year of data shall be stored for trending with data saved every 15 minutes. Daily totals shall also be saved. Each year, or at any time, the Operator shall be able to copy this data to a CD or DVD in a spreadsheet format.
13. All inline instrumentation shall be shown with instantaneous values on the HMI. One year of data shall be stored for trending. Each year, or at any time, the Operator shall be able to copy this data to a CD or DVD in a spreadsheet format.
14. All data shall be automatically graphed when chosen by the operator. These trending graphs shall not reset when closed or when the operator switches between data screens or other graphs.
15. All bits/elements in PLC logic shall be commented. If not used, then comment as SPARE.
16. SCADA historical graphs shall include programming to constantly refresh to appear as a "live, historical trend".

G. SCADA Programming Funtional Requirements

1. The Functional Descriptions below are intended to aid in defining the scope of work for PLC/OIT/HMI programming. These functional descriptions are intended to be supplemental to the requirements as shown on the Drawings. Hardwired interlocks for equipment control may not be described below. Hardwired interlocks shall be mimicked in PLC logic.
2. Where the referenced detail applies to multiple, similar equipment controls, only one is described. Control for associated equipment is similar.
3. Reference the PLC I/O schedules. The PLC I/O shall be utilized by PLC/HMI programming, as required, to allow the respective equipment to function as described by the Contract Documents.
   a. All alarm and equipment status monitoring PLC I/O inputted into the Plant Control System (PCS) shall be annunciated via the HMI.
4. All references to set points as "adjustable" below shall include the capability to adjust the set point via the HMI.
5. <u>FUNCTIONAL DESCRIPTION INDEX:</u>
   a. "6. NF BUILDING SOFTENING SYSTEM"
   b. "7. CORROSION INHIBITOR CHEMICAL FEED SYSTEM"
   c. "8. SODIUM HYDROXIDE CHEMICAL FEED SYSTEM"
   d. "9. ANTISCALANT CHEMICAL FEED SYSTEM"
   e. "10. SODIUM HYPOCHLORITE CHEMICAL FEED SYSTEM"
   f. "11. FLUORIDE CHEMICAL FEED SYSTEM"
   g. "12. EXISTING PROCESS CONTROL MODIFICATIONS"

h. "13. EMERGENCY POWER"
i. "14. CRITICAL ALARMS"

6. NF BUILDING SOFTENING SYSTEM
   a. NF Bypass Flow
      1) General: Used to continuously monitor the NF Bypass flow rate.
      2) Control:
         a) Local: None
         b) PCS: None
      3) Logic Interlocks/Permissives:
         a) Reference the NF Bypass Flow Control Loop
      4) Monitoring:
         a) Local: Instantaneous flow indication
         b) PCS: NF Bypass Flow
      5) Alarms:
         a) Local: None
         b) PCS: High-High, High, Low, Low-Low NF Bypass Flow, Loss of Signal
   b. NF Bypass Flow Control Valve
      1) General: Used to divert flow around the membrane skids.
      2) Control:
         a) Local: With the LOCAL-STOP-REMOTE selector switch at the actuator in the LOCAL position, the operator can open or close the valve by using the OPEN-CLOSE selector switch at the actuator. With the LOCAL-STOP-REMOTE selector switch at the actuator in the STOP position, the actuator will stop and maintain its current position.
         b) PCS: With the LOCAL-STOP-REMOTE selector switch at the actuator in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the NF Bypass Flow Control Valve via the HMI.
            (1) PC MANUAL: The operator shall have the ability to manually set a desired position.
            (2) AUTO: The NF Bypass Flow Control Valve shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED, HARDNESS, and PERCENT control modes.
               (a) FIXED: The valve position shall vary in order to maintain an operator entered desired NF Bypass Flow rate.
               (b) HARDNESS: The valve position shall vary in order to maintain an operator entered desired Blended Water Hardness.
                  a. If no groundwater well pumps are operating and a plant run command is active, the valve shall move to the operator entered plant startup initial position and shall remain at that position until a groundwater well pump starts operating.

b. Flow rate = [(BW flowrate x BW hardness) – (NFP flowrate x NFP hardness)] / NFF hardness

(c) PERCENT: The valve position shall vary in order to maintain an operator entered desired NF Bypass Flow rate as a percentage of Blended Water Flow.

a. If no groundwater well pumps are operating and a plant run command is active, the valve shall move to the operator entered plant startup initial position and shall remain at that position until a groundwater well pump starts operating.

3) Logic Interlocks/Permissives: None
4) Monitoring:
   a) Local: Opened, Closed, Position
   b) PCS: Remote, Opened, Closed, Position
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal

c. Cartridge Filter 1 Differential Pressure
1) General: Used to monitor if the Cartridge Filter needs cleaned.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous differential pressure indication
   b) PCS: Cartridge Filter 1 Differential Pressure
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Cartridge Filter 1 Differential Pressure, Loss of Signal

d. NF Bypass Header Pressure
1) General: Used to continuously monitor the pressure for NF Bypass Header.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Used for Groundwater Wells speed control.
4) Monitoring:
   a) Local: Instantaneous pressure indication
   b) PCS: NF Bypass Header Pressure
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low NF Bypass Header Pressure, Loss of Signal

e. NF Feed Pump 1 Suction Pressure
1) General: Used to continuously monitor the pressure for NF Feed Pump 1 Suction.
2) Control:

a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) None

4) Monitoring:
a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pump 1 Suction Pressure

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pump 1 Suction Pressure, Loss of Signal

f. NF Feed Pump 1

1) General: Used to source water to the membrane skids.

2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) VFD: The VFD frequency can be manually adjusted utilizing the potentiometer or VFD HIM module at the VFD.
c) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of NF Feed Pump 1 via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop and adjust the frequency of NF Feed Pump 1.
(2) AUTO: NF Feed Pump 1 shall be automatically controlled via PLC programming. NF Feed Pump 1 speed shall be varied as called for by the NF Skids Master PLC.

3) Logic Interlocks/Permissives: None

4) Monitoring:
a) Local: Running, Stopped, Vibration, Bearing Temp, Stator Temp
b) VFD: Running, Stopped, Frequency, Amps, Volts
c) PCS: Remote, Running, Stopped, Vibration, Bearing Temp, Stator Temp, Frequency, Amps, Volts, VFD LOR Switch Position

5) Alarms:
a) Local: General Alarm, High Vibration Alarm, High Bearing Temp Alarm, High Stator Temp Alarm
b) VFD: VFD Fault Alarm
c) PCS: Motor High Temperature, High Vibration Alarm, High Bearing Temp Alarm, High Stator Temp Alarm, Low Suction Pressure, High Discharge Pressure, VFD Fault, Loss of Signal

g. NF Feed Pump 1 Discharge Pressure

1) General: Used to continuously monitor the pressure for NF Feed Pump 1 Discharge.

2) Control:
a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) None

4) Monitoring:

a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pump 1 Discharge Pressure

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pump 1 Discharge Pressure, Loss of Signal

h. Blended Water Flow
1) General: Used to continuously monitor the Blended Water flow rate.
2) Control:
a) Local: None
b) PCS: Operator shall have the ability to select MAINTENANCE, FLOWMETER, or SUM TOTAL as the BW Flow signal source via the HMI.
(1) MAINTENANCE: The operator shall have the ability to enter in a flow value during flowmeter maintenance to reduce impact on chemical feed systems.
(2) FLOWMETER: The signal from this flowmeter is used.
(3) SUM TOTAL: The sum of all Skid Discharge Flows plus the NF Bypass Flow signal is used.

3) Logic Interlocks/Permissives:
a) Used for the chemical feed dosing calculations.
4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: Blended Water Flow
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Flow, Loss of Signal

i. Blended Water pH
1) General: Used to continuously monitor the pH level of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Used for chemical feed dosing calculations.
4) Monitoring:
a) Local: Instantaneous pH indication
b) PCS: Blended Water pH
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water pH, Loss of Signal

j. Blended Water Chlorine Residual
1) General: Used to continuously monitor the chlorine residual of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:

a) Local: Instantaneous Chlorine Residual indication
b) PCS: Blended Water Chlorine Residual

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Chlorine Residual, Loss of Signal

k. Blended Water Fluoride Residual
1) General: Used to continuously monitor the fluoride residual of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous Fluoride Residual indication
b) PCS: Blended Water Fluoride Residual
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Fluoride Residual, Loss of Signal

l. Blended Water Phosphate Residual
1) General: Used to continuously monitor the phosphate residual of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous Phosphate Residual indication
b) PCS: Blended Water Phosphate Residual
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Phosphate Residual, Loss of Signal

m. NF Concentrate Conductivity
1) General: Used to continuously monitor the conductivity of the skid concentrate.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous conductivity indication
b) PCS: NF Concentrate Conductivity
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Concentrate Conductivity, Loss of Signal

n. NF Concentrate pH
   1) General: Used to continuously monitor the pH level of the NF Concentrate.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) None
   4) Monitoring:
      a) Local: Instantaneous pH indication
      b) PCS: NF Concentrate pH
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low NF Concentrate pH, Loss of Signal

o. NF Skid Control Interface
   1) General: All control of individual NF Skids, Membrane Cleaning System, and associated equipment is performed by the NF Skids Master PLC. Custom programming requirements for that vendored system are specified under Section 466340. Programming requirements described below are provided under this Section for NF Building ACP PLC/OIT and SCADA.
   2) Operator shall have the ability to enter the following water quality parameters for NF Feed and NF Permeate. These values will be used to determine the NF Bypass flowrate when operated in HARDNESS mode.
      a) Total Hardness in NF Feed (THNFF = 366 mg/L as $CaCO_3$
      b) Total Hardness in NF Permeate (THNFP = 10.8 mg/L as $CaCO_3$
   3) PLC shall calculate and SCADA shall indicate and trend the following:
      a) Total NF Feed flow rate (Total NFF = NFP + NFC)
      b) NF Bypass Flow (NFB = NFP x %NFB).
      c) Indicate Raw Water Flow Rate (RW = NFF + NFB).
      d) Actual %NFB (%NFB = NFB / BLW)
         (1) NFB from flow meter
         (2) BLW = NFP flow meters from skids + NFB flow meter
         (3) THBLW = [(NFB x THNFF) + (NFP x THNFP)] / BW
   4) All Skid OIT and MCS screen information and operator entry shall be duplicated at SCADA.

p. NF Process Start/Stop
   1) Control: Operator shall have the ability to place the softening process on automated Start/Stop control. If enabled, the plant shall start if the existing clearwell level drops below an operator adjustable setpoint. The plant shall shutdown if the clearwell level rises above an operator adjustable setpoint.
   2) When the plant startup is auto initiated:
      a) Open NF Bypass Valve to initial setpoint.
      b) Start Chemical Feed Systems.
      c) Start Groundwater Wells.
      d) Start NF Feed Pumps and NF Skids. The quantity of skids needed shall be based on NF Skid Call Level setpoints.
   3) When the plant shutdown is auto initiated:
      a) NF Skids and NF Feed Pumps shall perform a permeate flush or forward flush before stopping.
      b) Groundwater Wells shall continue to operate until all NF Skids and NF Feed Pumps have stopped.

c) Close NF Bypass Valve.
d) Stop Chemical Feed Systems.

7. CORROSION INHIBITOR CHEMICAL FEED SYSTEM
   a. Corrosion Inhibitor Storage Tank 1 Level
      1) General: Used to continuously monitor the liquid level in Corrosion Inhibitor Storage Tank 1.
      2) Control:
         a) Local: None
         b) PCS: None
      3) Logic Interlocks/Permissives:
         a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
      4) Monitoring:
         a) Local: Instantaneous level indication
         b) PCS: Corrosion Inhibitor Storage Tank 1 Level
      5) Alarms:
         a) Local: None
         b) PCS: High-High, High, Low, Low-Low Corrosion Inhibitor Storage Tank 1 Level, Loss of Signal
   b. Corrosion Inhibitor Storage Tank 1 Outlet Valve
      1) General: Used to isolate Corrosion Inhibitor Storage Tank 1 from the outlet header.
      2) Control:
         a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
         b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
            (4) PC MANUAL: The operator shall have the ability to open or close the valve.
            (5) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.
      3) Logic Interlocks/Permissives:
         a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
      4) Monitoring:
         a) Local: Opened, Closed
         b) PCS: Remote, Opened, Closed
      5) Alarms:
         a) Local: None
         b) PCS: None
   c. Corrosion Inhibitor Storage Tank 1 Recirc Valve
      1) General: Used to direct chemical to Corrosion Inhibitor Storage Tank 1 from the transfer pump.
      2) Control:
         a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.

b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Corrosion Inhibitor Transfer Pump
1) General: Used to pump Corrosion Inhibitor chemical between tanks.
2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Corrosion Inhibitor Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Corrosion Inhibitor Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

e. Corrosion Inhibitor Day Tank Inlet Valve
1) General: Used to direct chemical to Corrosion Inhibitor Day Tank from the transfer pump.
2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.

b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

f. Corrosion Inhibitor Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
a) Local: None.
b) PCS: None.
3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Corrosion Inhibitor Day Tank High Level

g. Corrosion Inhibitor Day Tank Weight
1) General: Used to continuously monitor the weight of the Corrosion Inhibitor Day Tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
a) Local: Instantaneous weight indication
b) PCS: Corrosion Inhibitor Day Tank Weight
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Corrosion Inhibitor Day Tank Weight, Loss of Signal

h. Corrosion Inhibitor Feed Pump 1
1) General: Used to inject Corrosion Inhibitor into the water for treatment.
2) Control:
a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.

b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
   (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
   (2) AUTO: Corrosion Inhibitor Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
      (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
      (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint.

3) Logic Interlocks/Permissives:
   a) Corrosion Inhibitor Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Corrosion Inhibitor Chemical Transfer Sequence
1) General: Used for automated control of transferring chemical between tanks.
2) Control:
   a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
   b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
      (1) TRANSFER:
         a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
         b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
         c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
         d. Once both opened, the transfer pump shall operate until the Stop level is reached.
         e. Once the level is reached, both valves shall travel closed.
         f. Once either valve is closed, the transfer pump shall stop.
         g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
         h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.

i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:
a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:
a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Corrosion Inhibitor Feed Room Emergency Eyewash/Shower Flow Switch
1) General: Used to detect an activation of the emergency eyewash/shower.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None

4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Corrosion Inhibitor Feed Room Emergency Eyewash/Shower Activated

k. Corrosion Inhibitor Containment Area Wet Floor Switch
1) General: Used to detect a Corrosion Inhibitor tank leak.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Corrosion Inhibitor Containment Area Wet Floor Switch Activated

8. SODIUM HYDROXIDE CHEMICAL FEED SYSTEM
a. Sodium Hydroxide Storage Tank 1 Level
1) General: Used to continuously monitor the liquid level in Sodium Hydroxide Storage Tank 1.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous level indication
   b) PCS: Sodium Hydroxide Storage Tank 1 Level
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Storage Tank 1 Level, Loss of Signal

b. Sodium Hydroxide Storage Tank 1 Outlet Valve
1) General: Used to isolate Sodium Hydroxide Storage Tank 1 from the outlet header.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.

(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

c. Sodium Hydroxide Storage Tank 1 Recirc Valve
1) General: Used to direct chemical to Sodium Hydroxide Storage Tank 1 from the transfer pump.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

d. Sodium Hydroxide Transfer Pump
1) General: Used to pump Sodium Hydroxide chemical between tanks.
2) Control:
   a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
   b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
      (2) AUTO: Sodium Hydroxide Transfer Pump shall be automatically controlled via PLC programming. The pump

shall operate as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Alarm
   b) PCS: Motor High Temperature, Motor Overload

e. Sodium Hydroxide Day Tank Inlet Valve
1) General: Used to direct chemical to Sodium Hydroxide Day Tank from the transfer pump.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

f. Sodium Hydroxide Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
   a) Local: None.
   b) PCS: None.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Sodium Hydroxide Day Tank High Level

g. Sodium Hydroxide Day Tank Weight
1) General: Used to continuously monitor the weight of the Sodium Hydroxide Day Tank.
2) Control:

a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Sodium Hydroxide Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Day Tank Weight, Loss of Signal

h. Sodium Hydroxide Feed Pump 1
1) General: Used to inject Sodium Hydroxide into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
      (2) AUTO: Sodium Hydroxide Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
         (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
         (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired Blended Water pH setpoint.
3) Logic Interlocks/Permissives:
   a) Sodium Hydroxide Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Sodium Hydroxide Carrier Water Valve
1) General: Used to convey chemical for injection into the process stream.
2) Control:
   a) Local: None
   b) PCS: The operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall be open when any Sodium Hydroxide Feed Pump is operating.

3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: None
   b) PCS: Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

j. Sodium Hydroxide Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
      b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
         (1) TRANSFER:
            a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
            d. Once both opened, the transfer pump shall operate until the Stop level is reached.
            e. Once the level is reached, both valves shall travel closed.
            f. Once either valve is closed, the transfer pump shall stop.
            g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
            h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
            i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
            j. All applicable equipment must not have any active alarms in order to initiate the transfer.
         (2) RECIRC:
            a. The operator shall select a storage tank and enter a desired time duration setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
            d. Once both opened, the transfer pump shall operate until the time duration has expired.
            e. Once time expires, both valves shall travel closed.
            f. Once either valve is closed, the transfer pump shall stop.

g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

k. Sodium Hydroxide Feed Room Emergency Eyewash/Shower Flow Switch
1) General: Used to detect an activation of the emergency eyewash/shower.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hydroxide Feed Room Emergency Eyewash/Shower Activated

l. Sodium Hydroxide Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Hydroxide tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None

5) Alarms:
   a) Local: None
   b) PCS: Sodium Hydroxide Containment Area Wet Floor Switch Activated

m. Sodium Hydroxide Feed Room Temperature
   1) General: Used to continuously monitor the temperature of the Sodium Hydroxide Feed Room.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) None
   4) Monitoring:
      a) Local: Instantaneous temperature indication
      b) PCS: Sodium Hydroxide Feed Room Temperature
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Feed Room Temperature, Loss of Signal

9. ANTISCALANT CHEMICAL FEED SYSTEM
   a. Antiscalant Transfer Pump
      1) General: Used to pump Antiscalant chemical between tanks.
      2) Control:
         a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
         b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
            (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
            (2) AUTO: Antiscalant Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Antiscalant Chemical Transfer Sequence.
      3) Logic Interlocks/Permissives:
         a) Reference the Antiscalant Chemical Transfer Sequence.
      4) Monitoring:
         a) Local: Running, Stopped
         b) PCS: Running, Stopped, Remote
      5) Alarms:
         a) Local: Alarm
         b) PCS: Motor High Temperature, Motor Overload
   b. Antiscalant Day Tank High Level
      1) General: Used to prevent overfilling the day tank.
      2) Control:
         a) Local: None.
         b) PCS: None.
      3) Logic Interlocks/Permissives:

a) Reference the Antiscalant Chemical Transfer Sequence.

4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Antiscalant Day Tank High Level

c. Antiscalant Day Tank Weight
1) General: Used to continuously monitor the weight of the Antiscalant Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Antiscalant Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Antiscalant Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Antiscalant Day Tank Weight, Loss of Signal

d. Antiscalant Feed Pump 1
1) General: Used to inject Antiscalant into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
      (2) AUTO: Sodium Bisulfite Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
         (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
         (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint using the sum of all Skid Inlet Flows.
3) Logic Interlocks/Permissives:
   a) Antiscalant Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault

b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

e. Antiscalant Injection Flow
   1) General: Used to detect that Antiscalant is being injected into the process stream.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) An Antiscalant Feed Pump must be operating for alarm logic to be active.
      b) Antiscalant flow must be present for an NF Skid to operate.
   4) Monitoring:
      a) Local: None
      b) PCS: None
   5) Alarms:
      a) Local: None
      b) PCS: Antiscalant No Flow Alarm

f. Antiscalant Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
      b) PCS: The operator shall be able to fill the day tank automatically using PLC programming.
         (1) DAY TANK FILL:
            a. The operator shall select the source storage tank and enter a Stop weight setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the transfer pump shall operate until the Stop weight is reached.
            d. Once the weight is reached, the transfer pump shall stop.
            e. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
            f. Day Tank High Level Alarm must be inactive for the transfer pump to start.
            g. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
            h. All applicable equipment must not have any active alarms in order to initiate the transfer.

10. SODIUM HYPOCHLORITE CHEMICAL FEED SYSTEM
    a. Sodium Hypochlorite Storage Tank 1 Level
       1) General: Used to continuously monitor the liquid level in Sodium Hypochlorite Storage Tank 1.
       2) Control:
          a) Local: None
          b) PCS: None
       3) Logic Interlocks/Permissives:

a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.

4) Monitoring:
   a) Local: Instantaneous level indication
   b) PCS: Sodium Hypochlorite Storage Tank 1 Level

5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Storage Tank 1 Level, Loss of Signal

b. Sodium Hypochlorite Storage Tank 1 Outlet Valve

1) General: Used to isolate Sodium Hypochlorite Storage Tank 1 from the outlet header.

2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (3) PC MANUAL: The operator shall have the ability to open or close the valve.
      (4) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.

4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed

5) Alarms:
   a) Local: None
   b) PCS: None

c. Sodium Hypochlorite Storage Tank 1 Recirc Valve

1) General: Used to direct chemical to Sodium Hypochlorite Storage Tank 1 from the transfer pump.

2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hypochlorite Chemical Transfer Sequence

4) Monitoring:

a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Sodium Hypochlorite Dilution Water Flow
1) General: Used to continuously monitor the Sodium Hypochlorite Dilution Water flow rate.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Dilution Control Loop.
4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: Sodium Hypochlorite Dilution Water Flow
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Dilution Water Flow, Loss of Signal

e. Sodium Hypochlorite Storage Tank 1 Dilution Water Valve
1) General: Used to direct dilution water to Sodium Hypochlorite Storage Tank 1 to lower the solution concentration.
2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Dilution Control Loop.
3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Dilution Control Loop.
4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed
5) Alarms:
a) Local: None
b) PCS: None

f. Sodium Hypochlorite Transfer Pump
1) General: Used to pump Sodium Hypochlorite chemical between tanks.
2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.

b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Sodium Hypochlorite Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Sodium Hypochlorite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

g. Sodium Hypochlorite Day Tank Inlet Valve

1) General: Used to direct chemical to Sodium Hypochlorite Day Tank from the transfer pump.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

h. Sodium Hypochlorite Day Tank Level

1) General: Used to continuously monitor the liquid level in Sodium Hypochlorite Day Tank.

2) Control:
a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.

4) Monitoring:

a) Local: Instantaneous level indication
b) PCS: Sodium Hypochlorite Day Tank Level

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Day Tank Level, Loss of Signal

i. Sodium Hypochlorite Day Tank High Level

1) General: Used to prevent overfilling the day tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hypochlorite Day Tank High Level

j. Sodium Hypochlorite Feed Pump 1

1) General: Used to inject Sodium Hypochlorite into the water for disinfection treatment.
2) Control:
a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Hypochlorite Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Blended Water Flow.
3) Logic Interlocks/Permissives:
a) Sodium Hypochlorite Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote
5) Alarms:
a) Local: Fault
b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

k. Sodium Hypochlorite Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
      b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
         (1) TRANSFER:
            a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
            d. Once both opened, the transfer pump shall operate until the Stop level is reached.
            e. Once the level is reached, both valves shall travel closed.
            f. Once either valve is closed, the transfer pump shall stop.
            g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
            h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
            i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
            j. All applicable equipment must not have any active alarms in order to initiate the transfer.
         (2) RECIRC:
            a. The operator shall select a storage tank and enter a desired time duration setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
            d. Once both opened, the transfer pump shall operate until the time duration has expired.
            e. Once time expires, both valves shall travel closed.
            f. Once either valve is closed, the transfer pump shall stop.
            g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
            h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
            i. All applicable equipment must not have any active alarms in order to initiate the sequence.
         (3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Level Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Switch Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

l. Sodium Hypochlorite Dilution Control Loop
1) General: Used for automated control of adding dilution water to storage tanks to reduce the concentration of the solution.
2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to add dilution water.
b) PCS: The operator shall be able to add dilution water automatically using PLC programming.
(1) Dilution Water Sequence:
a. The operator shall select which storage tanks to add dilution water to and enter a GALLONS setpoint.
b. The applicable Storage Tank Dilution Water Valves will open.
c. Once the GALLONS setpoint has been reached, the valves shall close.
d. Applicable Storage Tank(s) High Level Alarm(s) must be inactive for the sequence to start.
e. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
f. All applicable equipment must not have any active alarms in order to initiate the sequence.

m. Sodium Hypochlorite Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Hypochlorite tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None

5) Alarms:
   a) Local: None
   b) PCS: Sodium Hypochlorite Containment Area Wet Floor Switch Activated

11. FLUORIDE CHEMICAL FEED SYSTEM
   a. Fluoride Storage Tank 1 Level
      1) General: Used to continuously monitor the liquid level in Fluoride Storage Tank 1.
      2) Control:
         a) Local: None
         b) PCS: None
      3) Logic Interlocks/Permissives:
         a) Reference the Fluoride Chemical Transfer Sequence.
      4) Monitoring:
         a) Local: Instantaneous level indication
         b) PCS: Fluoride Storage Tank 1 Level
      5) Alarms:
         a) Local: None
         b) PCS: High-High, High, Low, Low-Low Fluoride Storage Tank 1 Level, Loss of Signal
   b. Fluoride Storage Tank 1 Outlet Valve
      1) General: Used to isolate Fluoride Storage Tank 1 from the outlet header.
      2) Control:
         a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
         b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
            (1) PC MANUAL: The operator shall have the ability to open or close the valve.
            (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.
      3) Logic Interlocks/Permissives:
         a) Reference the Fluoride Chemical Transfer Sequence.
      4) Monitoring:
         a) Local: Opened, Closed
         b) PCS: Remote, Opened, Closed
      5) Alarms:
         a) Local: None
         b) PCS: None
   c. Fluoride Storage Tank 1 Recirc Valve
      1) General: Used to direct chemical to Fluoride Storage Tank 1 from the transfer pump.
      2) Control:
         a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-

REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.

b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.

(1) PC MANUAL: The operator shall have the ability to open or close the valve.

(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:

a) Reference the Fluoride Chemical Transfer Sequence

4) Monitoring:

a) Local: Opened, Closed

b) PCS: Remote, Opened, Closed

5) Alarms:

a) Local: None

b) PCS: None

d. Fluoride Transfer Pump

1) General: Used to pump Fluoride chemical between tanks.

2) Control:

a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.

b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.

(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.

(2) AUTO: Fluoride Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Fluoride Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:

a) Reference the Fluoride Chemical Transfer Sequence.

4) Monitoring:

a) Local: Running, Stopped

b) PCS: Running, Stopped, Remote

5) Alarms:

a) Local: Alarm

b) PCS: Motor High Temperature, Motor Overload

e. Fluoride Day Tank Inlet Valve

1) General: Used to direct chemical to Fluoride Day Tank from the transfer pump.

2) Control:

a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.

b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed
5) Alarms:
a) Local: None
b) PCS: None

f. Fluoride Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Fluoride Day Tank High Level

g. Fluoride Day Tank Weight
1) General: Used to continuously monitor the weight of the Fluoride Day Tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
a) Local: Instantaneous weight indication
b) PCS: Fluoride Day Tank Weight
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Fluoride Day Tank Weight, Loss of Signal

h. Fluoride Feed Pump 1
1) General: Used to inject Fluoride into the water for treatment.
2) Control:
a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.

b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
   (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
   (2) AUTO: Fluoride Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
      (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
      (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Blended Water Flow.

3) Logic Interlocks/Permissives:
   a) Fluoride Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Fluoride Chemical Transfer Sequence
1) General: Used for automated control of transferring chemical between tanks.
2) Control:
   a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
   b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
      (1) TRANSFER:
         a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
         b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
         c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
         d. Once both opened, the transfer pump shall operate until the Stop level is reached.
         e. Once the level is reached, both valves shall travel closed.
         f. Once either valve is closed, the transfer pump shall stop.
         g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
         h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.

i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:
a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:
a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Fluoride Containment Area Wet Floor Switch
1) General: Used to detect a Fluoride tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None

4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Fluoride Containment Area Wet Floor Switch Activated

12. EXISTING PROCESS CONTROL MODIFICATIONS
    a. Groundwater Wells
       1) General: Used to pump water to the NF Building Softening process.
       2) Control: Modify groundwater pumps to operate when NF Skids are being called to run.
          a) AUTO: Wells shall be automatically controlled via PLC programming. Well's with VFD controllers shall have their speed varied to maintain an operator entered NF Bypass Header Pressure setpoint.
          b) Groundwater pumps operating is a permissive in order for NF Skids to start.

13. EMERGENCY POWER

    a. Automatic Transfer Switch
       1) General: Used to automatically transfer plant power to generator during a utility power outage.
       2) Control:
          a) Local: Per manufacturer
          b) PCS: None
       3) Logic Interlocks/Permissives:
          a) Generator running and Automatic Transfer Switch in the Emergency Source position will initiate step loading logic for loads to be sequentially started.
       4) Monitoring:
          a) Local: Per manufacturer
          b) PCS: Utility Source Available, Emergency Source Available, Utility Source Connected, Emergency Source Connected
       5) Alarms:
          a) Local: Per manufacturer
          b) PCS: Not in Auto

14. CRITICAL ALARMS

    a. General: Programming shall include the following as critical alarms. Critical alarms shall initiate a telephone call to designated personnel.
       1) Utility Power Failure
       2) PLC Failure Alarm
       3) Emergency NF Process Shutdown

3.2 EXAMINATION

A. Verification of Conditions: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Discrepancies: In the event any discrepancies are discovered, immediately notify the Owner's Representative in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 PREPARATION

A. Protection
   1. All equipment and materials shall be packed at the factory to protect each item from damage during shipment and storage.
   2. Provide blocking and cushioning materials to prevent damage during shipment.
   3. Panel mounted instruments and equipment to be installed inside enclosures, panels, or consoles shall be mounted and assembled at the panel manufacturer's facility.

3.4 INSTALLATION

A. General: Install equipment, as indicated, with manufacturer's written instructions and with recognized industry practices.

3.5 FIELD QUALITY CONTROL

A. Inspection: Provide for services of a qualified representative of the manufacturer to inspect and approve installation.

B. Tests: Upon completion of all inspections, and prior to acceptance, perform field tests outlined in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

C. Operational Demonstration: After completion of the field test, perform a 30-day operational demonstration as specified in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.6 DEMONSTRATION

A. General: When all required tests have been performed and prior to final acceptance, the Contractor shall perform a 30-day operational demonstration in accordance with the requirements of Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.7 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.

B. Quantity: Provide spares for each type of module listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
   1. Processor Modules
   2. Power Supply
   3. Digital Input Modules

4. Digital Output Modules
5. Analog Input Modules
6. Analog Output Modules
7. Analog Input/Analog Output Modules
8. Flex I/O Modules
9. Flex I/O Module Terminal Blocks

C. Provide (6) OIT protective screen overlays.

D. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no cost.

3.8 PLC SYSTEM TRAINING

A. General.
1. Provide a training course customized for the control system hardware.
2. Provide training on the operation and maintenance of the control system hardware.
3. Provide training manuals for each attendee plus two additional manuals in archival preservation at the project site.
4. Include the following in each manual.
   a. An agenda
   b. Defined objectives for each lesson.
5. Provide all equipment, materials, and supplies used in the training.
6. For guidance in planning the required instruction, assume that attendees will have a high school education or equivalent and basic electrical maintenance knowledge.

B. Location, duration, and schedule.
1. Teach the course at the project site.
2. Provide one day of training for five personnel designated by the Owner.
3. Conduct training after completion of the Contractor's field testing.

3.9 INPUT/OUTPUT SCHEDULE

A. Abbreviations
1. AI = Analog Input
2. AO = Analog Output
3. CPU = Processor
4. DI = Digital Input
5. DO = Digital Output
6. RIO = Remote I/O Communications

B. Installed spare inputs and outputs (I/O): In addition to the I/O listed below, provide a minimum of 10 percent installed.
1. All SPARE I/O shall be wired to terminal blocks within the PLC enclosure.

END OF SECTION 40 9443

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

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PROVIDED BY RO OEM

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VALVE TAG	SIZE	VALVE TYPE	PROCESS FLOW	ACTUATOR	POSITION	ASSOCIATED EQUIPMENT	DESCRIPTION	GP SHEET	SPEC
BF 3X00	10	BUTTERFLY	NF FEED	PNEUM. OPEN/CLOSE	N.O.	NF SKID X	ISOLATION	GP-06	BFV-SST
BF 3X02	10	BUTTERFLY	PERM. FLUSH	PNEUM. OPEN/CLOSE	N.C.	NF SKID X	PERMEATE FLUSH ISOLATION	GP-06	BFV-SST
BA 3X03	-	BALL	PERM. FLUSH	ELECTRIC	N.C.	NF SKID X	PERMEATE FLUSH FEED BLEED	GP-06	BA-SST
BF 3X04	10	BUTTERFLY	NF FEED	HAND WHEEL	N.O.	NF SKID X	NF FEED ISOLATION	GP-06	BFV-SST
BA 3X05	-	BALL	NF FEED	LEVER	N.C.	NF SKID X	NF FEED DRAIN	GP-06	BA-SST
BF 3X06	10	BUTTERFLY	PERM. FLUSH	PNEUM. OPEN/CLOSE	N.C.	NF SKID X	PERMEATE FLUSH FEED ISOLATION	GP-06	BFV-SST
BF 3X10	-	BUTTERFLY	1ST STAGE CONC.	HAND WHEEL	N.O.	NF SKID X	2ND STAGE FEED ISOLATION	GP-06	BFV-SST
ARV 3X11	-	AIR RELEASE	1ST STAGE CONC.	NONE	N/A	NF SKID X	1ST STAGE CONCENTRATE AIR RELEASE	GP-06	ARV
BA 3X12	-	BALL	1ST STAGE CONC.	LEVER	N.O.	NF SKID X	1ST STAGE CONCENTRATE AIR RELEASE ISOLATION	GP-06	BA-SST
BA 3X20	-	BALL	1ST STAGE PERM.	ELEC. MODULATING	N.O.	NF SKID X	1ST STAGE PERMEATE THROTTLE VALVE	GP-06	BA-V-Notch
BF 3X21	-	BUTTERFLY	1ST STAGE PERM.	HAND WHEEL	N.O.	NF SKID X	1ST STAGE PERMEATE ISOLATION	GP-06	BFV-Coated
BF 3X30	-	BUTTERFLY	2ND STAGE PERM.	HAND WHEEL	N.O.	NF SKID X	2ND STAGE PERMEATE ISOLATION	GP-06	BFV-Coated
CK 3X40	8	CHECK	FINAL PERM.	NONE	N/A	NF SKID X	FINAL PERMEATE CHECK	GP-06	CV-SST
BF 3X41	8	BUTTERFLY	FINAL PERM.	PNEUM. OPEN/CLOSE	N.O.	NF SKID X	FINAL PERMEATE ISOLATION	GP-06	BFV-Coated
BF 3X42	8	BUTTERFLY	FINAL PERM.	HAND WHEEL	N.O.	NF SKID X	FINAL PERMEATE MANUAL ISOLATION	GP-06	BFV-Thermoplastic
BA 3X43	-	BALL	FINAL PERM.	LEVER	N.C.	NF SKID X	FINAL PERMEATE BLEED	GP-06	BA-Thermoplastic
BF 3X44	8	BUTTERFLY	PERM. DUMP	PNEUM. OPEN/CLOSE	N.C.	NF SKID X	PERMEATE DUMP ISOLATION	GP-06	BFV-Coated
GLV 3X50	-	GLOBE	2ND STAGE CONC.	ELEC. MODULATING	N.O.	NF SKID X	CONCENTRATE THROTTLING VALVE	GP-06	Globe-Conc.
BF 3X51	4	BUTTERFLY	2ND STAGE CONC.	PNEUM. OPEN/CLOSE	N.C.	NF SKID X	CONCENTRATE THROTTLING VALVE BYPASS/FLUSH	GP-06	BFV-Coated
BA 3X52	-	BALL	2ND STAGE CONC.	LEVER	N.C.	NF SKID X	2ND STAGE CONCENTRATE DRAIN	GP-06	BA-SST
CK 3X53	4	CHECK	2ND STAGE CONC.	NONE	N/A	NF SKID X	2ND STAGE CONCENTRATE CHECK	GP-06	CV-SST
BF 3X54	4	BUTTERFLY	FINAL CONC.	HAND WHEEL	N.O.	NF SKID X	FINAL CONCENTRATE ISOLATION	GP-06	BFV-SST
BF 3X60	8	BUTTERFLY	CSF	HAND WHEEL	N.C.	NF SKID X	CLEANING SOLUTION FEED ISOLATION	GP-06	BFV-Thermoplastic
BF 3X61	8	BUTTERFLY	CSF	HAND WHEEL	N.C.	NF SKID X	1ST STAGE CLEANING SOLUTION FEED ISOLATION	GP-06	BFV-SST
BF 3X62	-	BUTTERFLY	CSF	HAND WHEEL	N.C.	NF SKID X	2ND STAGE CLEANING SOLUTION FEED ISOLATION	GP-06	BFV-SST
BA 3X63	-	BALL	CSF	LEVER	N.C.	NF SKID X	CLEANING SOLUTION FEED BLEED	GP-06	BA-Thermoplastic
BF 3X70	4	BUTTERFLY	CSPR	HAND WHEEL	N.C.	NF SKID X	CLEANING SOLUTION PERMEATE RETURN ISOLATION	GP-06	BFV-Thermoplastic
BF 3X71	4	BUTTERFLY	CSPR	HAND WHEEL	N.C.	NF SKID X	CLEANING SOLUTION PERMEATE RETURN ISOLATION	GP-06	BFV-Thermoplastic
BA 3X72	-	BALL	CSPR	LEVER	N.O.	NF SKID X	CLEANING SOLUTION PERMEATE RETURN BLEED	GP-06	BA-Thermoplastic
BF 3X80	4	BUTTERFLY	FINAL CONC.	HAND WHEEL	N.O.	NF SKID X	FINAL CONCENTRATE/1ST STAGE CSCR INTERCONNECT	GP-06	BFV-SST
BF 3X81	6	BUTTERFLY	1ST STAGE CSCR	HAND WHEEL	N.C.	NF SKID X	1ST STAGE CLEANING SOLUTION CONCENTRATE RETURN ISOLATION	GP-06	BFV-SST
BF 3X82	6	BUTTERFLY	1ST STAGE CSCR	HAND WHEEL	N.C.	NF SKID X	1ST STAGE CLEANING SOLUTION CONCENTRATE RETURN ISOLATION	GP-06	BFV-Thermoplastic
BA 3X83	-	BALL	1ST STAGE CSCR	LEVER	N.C.	NF SKID X	1ST STAGE CLEANING SOLUTION CONCENTRATE RETURN BLEED	GP-06	BA-SST

PIPING SCHEDULE

Process Flow Abbreviation	Process Flow Description	Pipe Material - Above Grade
CFI	Cartridge Filter Inlet	Ductile Iron
NFB	Nanofiltration Bypass	Ductile Iron
NFF	Nanofiltration Feed	Stainless Steel
NFC	Nanofiltration Concentrate	Ductile Iron
NFD	Nanofiltration Permeate Dump	Ductile Iron
NFP	Nanofiltration Permeate	Ductile Iron and SCH 80 PVC (as indicated on drawings)
CSF	Cleaning Solution Feed	SCH 80 PVC
CSPR	Cleaning Solution Permeate Return	SCH 80 PVC
CSCR	Cleaning Solution Concentrate Return	SCH 80 PVC
BLW	Blended Water	Ductile Iron
AIR	Air	Stainless Steel
NaHSO3	Sodium Bisulfite	Rigid Piping: SCH 80 PVC Flexible Tubing: Polyethylene Tubing
A.S.	Antiscalant	Rigid Piping: SCH 80 PVC Flexible Tubing: Polyethylene Tubing
NaOCl	Sodium Hypochlorite	Rigid Piping: SCH 80 PVC Flexible Tubing: Polyethylene Tubing
NaOH	Sodium Hydroxide	Rigid Piping: SCH 80 PVC Flexible Tubing: Polyethylene Tubing
FLUOR.	Fluoride	Rigid Piping: SCH 80 PVC Flexible Tubing: Polyethylene Tubing
PHOS.	Corrosion Inhibitor	Rigid Piping: SCH 80 PVC Flexible Tubing: Polyethylene Tubing

AECOM

PROJECT

FAWTP MEMBRANE SOFTENING UPGRADES

FRANKLIN AREA WTP
6648 Shelly Street
Franklin, Oh 45005

CLIENT

WARREN COUNTY

Warren County Administration Building
406 Justice Drive
Lebanon, Oh 45036
513-695-1250 tel
http://www.co.warren.oh.us

CONSULTANT

AECOM
277 West Nationwide Boulevard
Columbus, OH 43215-2566
614.464.4500 tel 614.464.0588 fax
www.aecom.com

CONSULTANTS

ARCHITECTURAL, CIVIL, & STRUCTURAL
ARCADIS U.S., INC.
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Cincinnati, Oh 45241
513.860.8700 tel 513.860.8701 fax
www.arcadis.com

SURVEY
RA Consultants, LLC.
10856 Kenwood Road
Blue Ash, Oh 45242
513.469.6600 tel 513.469.2684 fax
www.raconsultantsllc.com

GEOTECHNICAL
IDE
2451 Crowne Point Drive
Cincinnati, Oh 45241
513.671.8144 tel 513.671.8150 fax
www.ide-oh.com

REGISTRATION

ISSUE/REVISION

1	2020-05-08	ADDENDUM No. 1
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60551697

SHEET TITLE

VALVE SCHEDULE

SHEET NUMBER

GP-15

TO ALL DOCUMENT HOLDERS:

Subject: WCWSD RARWTP Membrane Softening Upgrades

AECOM Job No.: 60551697

Enclosed herewith is a copy of Addendum No. 2 covering the subject project.

Please retain this with your Documents.

Sincerely,

AECOM

Matthew Noelker, P.E.

Attachments: None

ADDENDUM TO THE
BIDDING DOCUMENTS
FOR:
Membrane Equipment Procurement

1.1 GENERAL

A. This Addendum covers changes to the Documents and in closing the Contract will become a part thereof. Each Bidder shall include these items to the extent they affect his Bid.

B. These items modify only the portion of the Documents specifically noted. All other wording and Drawings remain in effect.

1.2 CLARIFICATIONS

A. The following is a list of clarifications regarding project documents. These clarifications include question received during the advertisement period:

Q: Is a performance or a payment bond required?
A: No, the Buyer (General Contractor) will hold the performance and payment bond. See revisions to the project manual below.

Q: Coded note no. 6 on sheet I-01 (RARWTP) indicates new I/O modules shall be 1769-IA16 and 1769-IF41 by Allen-Bradley. This contradicts Section 40 9443 (RARWTP and FAWTP), paragraph 2.1. Please confirm the requirements for the SCADA System PLC components.

A: SCADA System PLC components shall be in accordance with 40 9443 (RARWTP and FAWTP), paragraph 2.1. Coded note no. 6 on sheet I-01 (RARWTP) refers to an existing panel at the RARWTP.

1.3 PROJECT MANUAL

A. Section 00 1113 – Advertisement for Bids
   1. Section 2.
      a. Revise:
      "Bids will be received by Engineer until May 18, 2020 @ 2:00 p.m. Bids shall be submitted via email or via hand delivery, USPS, UPS, or FedEx to: AECOM, ATTN: Matthew Noelker, P.E., 277 West Nationwide Blvd, Columbus, Ohio 43215, matthew.noelker@aecom.com" to read:
      "Bids will be received by Engineer until May 18, 2020 @ 2:00 p.m Bids shall be submitted via email to matthew.noelker@aecom.com. A webex invitation will follow for interested parties to view the bid opening."

B. Section 00 5215 – Agreement Form
   1. Paragraph 2.04.B – Add the following to the end of this paragraph:
      "Total combined liquidated damages payable by Seller to Buyer shall not exceed 25% of the Contract Price."

C. Section 00 7000 – General Conditions
   1. Paragraph 5.01 – Delete this paragraph.

2. Paragraph 7.07. Add the following as subparagraph C:
"Seller's total limit of liability to the Buyer shall be limited to 1.5 times the total procurement contract value."

D. Section 46 6340 – Nanofiltration Membrane Equipment
1. Paragraph 2.11.A.2 – Add the following to this paragraph:
"SDI test apparatus shall consist of an isolation valve, pressure reducing valve (hand-operated, design to regulate from up to 150 psi to 30 psi), and an SDI pad holder."
2. RARWTP RO MEMBRANE EQUIPMENT SCHEUDLE, paragraph A. Add the following as subparagraph 3:
"Maximum feed pressure shall be no greater than 140 psi when operating with 35 psig of permeate backpressure on stage 1 of the array and 15 psig of permeate backpressure on stage 2 of the array."
3. FAWTP RO MEMBRANE EQUIPMENT SCHEDULE, paragraph A. Add the following as subparagraph 3:
"Maximum feed pressure shall be no greater than 140 psi when operating with 35 psig of permeate backpressure on stage 1 of the array and 15 psig of permeate backpressure on stage 2 of the array."

END OF ADDENDUM NO. 2
(SEE ENCLOSURES)

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THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

SECTION 00 4113

BID FORM

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Page

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to the Engineer via email or via hand delivery, USPS, UPS, or FedEx to:

AECOM
ATTN: Matthew Noelker, P.E.
277 West Nationwide Blvd
Columbus, Ohio 43215
Matthew.noelker@aecom.com

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Buyer in the form included in the Bid Documents to furnish the Goods and Special Services as specified or indicated in the Bid Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bid Documents.

1.03 The Buyer of the Goods and Special Services will be the successful Bidder(s) (Contractor(s)) for the referenced Projects.

ARTICLE 2 – BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the RFP.

2.02 Bidder accepts the provision of the Agreement as to liquidated damages in event of its failure to furnish the Goods and Special Services in accordance with the schedule set forth in the Agreement.

ARTICLE 3 – BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bid Documents included with the RFP, other related data identified, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date
1	5/7/2020
2	5/14/2020

B. Bidder has become familiar with and is satisfied as to the local conditions that may affect cost, progress, delivery, or the furnishing of Goods and Special Services.

C. Bidder is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress, and the furnishing of Goods and Special Services.

D. Bidder has carefully studied and correlated the information known to Bidder, and information and observations obtained from Bidder's visits, if any, to the Point of Destination with the Bid Documents.

E. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bid Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

F. The Bid Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing the Goods and Special Services for which this Bid is submitted.

G. Bidder further represents that this Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any individual or entity to refrain from Bid; and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Buyer.

ARTICLE 4 – BASIS OF BID

ADD #1

4.01 Bidder will furnish the Goods and Special Services in accordance with these Contract Documents for the following price(s), which do not include sales tax. Prices shall be guaranteed until August 31, 2020. After this date, **if the Owner has not issued a Notice to Proceed to Buyer, and** if requested by the ~~**Buyer**~~ **Seller** and approved by the Owner, ~~**Buyer's**~~ **Seller's** proposed prices may be escalated by the monthly change of the U.S. Consumer Price Index (CPI) as calculated by the U.S. Bureau of Labor Statistics.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

RARWTP

ADD #1

Item No.	Description	Proposed Price
	SHOP DRAWINGS	
1.)	Shop Drawing Preparation	**$60,000.00**
	EQUIPMENT	
2.)	Base Bid: Manufacturing of Goods—Epoxy Coated or FRP Frames Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	**$2,335,351.00**
3.)	Base Bid: Assembly of Goods Onsite—Epoxy Coated or FRP Frames Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	NA Fully Assembled and Skid Mounted except MCS per the specifications. Since MCS is being partially supplied by Contractor, they are responsible for installation.
4.)	Alternate Bid: Manufacturing of Goods—304 SST Frames (Item cost is additive or deductive from Item No. 2). Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	**Add** **$26,100.00**
5.)	Alternate Bid: Assembly of Goods Onsite—304 SST Frames (Item cost is additive or deductive from Item No. 3). Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	NA Fully Assembled and Skid Mounted except MCS per the specifications. Since MCS is being partially supplied by Contractor, they are responsible for installation.
	SPECIAL SERVICES	
6.)	Include costs required for all Special Services including startup and commissioning, remote monitoring, and field service agreement.	**$134,000.00**

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

FAWTP

ADD #1

Item No.	Description	Proposed Price
	SHOP DRAWINGS	
7.)	Shop Drawing Preparation	**$60,000.00**
	EQUIPMENT	
8.)	Base Bid: Manufacturing of Goods—Epoxy Coated or FRP Frames Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	**$1,265,514.00**
9.)	Base Bid: Assembly of Goods Onsite—Epoxy Coated or FRP Frames Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	NA Fully Assembled and Skid Mounted except MCS per the specifications. Since MCS is being partially supplied by Contractor, they are responsible for installation.
10.)	Alternate Bid: Manufacturing of Goods—304 SST Frames (Item cost is additive or deductive from Item No. 2). Individual skids shall be delivered to the Point of Destination having been fully assembled, ready for installation, and having undergone factory acceptance testing prior to shipping. If skids are delivered not having been fully assembled, costs for such assembly shall be included under Item No. 3.	**Add** **$14,500.00**
11.)	Alternate Bid: Assembly of Goods Onsite—304 SST Frames (Item cost is additive or deductive from Item No. 3). Include all costs for any required onsite assembly of goods except the following items which will be performed by the Buyer: unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power. **All onsite labor wages shall be in accordance with Division 00, Section "Prevailing Wage Rate Requirements.**	NA Fully Assembled and Skid Mounted except MCS per the specifications. Since MCS is being partially supplied by Contractor, they are responsible for installation.
	SPECIAL SERVICES	
12.)	Include costs required for all Special Services including startup and commissioning, remote monitoring, and field service agreement.	**$123,000.00**

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TOTALS

RARWTP TOTAL LUMP SUM BASE BID

(1 + 2 + 3 + 6):

Two million five hundred twenty-nine thousand three hundred fifty-one (Words) Dollars $2,529,351.00 (Figures)

RARWTP TOTAL LUMP SUP ALTERNATE BID

(1 + 2 + 3 + 4 + 5 + 6):

Two million five hundred fifty-five thousand four hundred fifty-one (Words) Dollars $2,555,451.00 (Figures)

FAWTP TOTAL LUMP SUM BASE BID

(7 + 8 + 9 + 12):

One million four hundred forty-eight thousand five hundred fourteen (Words) Dollars $1,448,514.00 (Figures)

FAWTP TOTAL LUMP SUP ALTERNATE BID

(7 + 8 + 9 + 10 + 11 + 12):

One million four hundred sixty-three thousand fourteen (Words) Dollars $1,463,014.00 (Figures)

TOTAL LUMP SUM BASE BID (RARWTP + FAWTP)

Three million nine hundred seventy-seven thousand eight hundred sixty-five (Words) Dollars $3,977,865.00 (Figures)

TOTAL LUMP SUP ALTERNATE BID (RARWTP + FAWTP)

Four million eighteen thousand four hundred sixty-five (Words) Dollars $4,018,465.00 (Figures)

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

4.02 Additional Proposed Costs:

Description	Proposed Price
The Seller's monthly fee for storage of Goods at Seller's facilities in the event that Buyer desires to delay shipment beyond the shipment date stated below in Article 5.02. Such fee shall include interest on money due Seller.	RARWTP: $2500/month FAWTP: $1500/month
The Seller's monthly fee for Buyer delaying the initiation of manufacturing of Goods or for not executing the Procurement Agreement within the time specified in 4.03 below.	RARWTP: $5500/month FAWTP: $3500/month

4.03 Seller and Buyer shall execute the Procurement Agreement within 30 days after the Contractor's/Buyer's Notice to Proceed from the Owner. Should the Procurement Agreement not be executed within said 30 days due to the fault of the Buyer, the Buyer shall be subject to the prorated additional costs identified in Paragraph 4.02 above. Should the Procurement Agreement not be executed within the said 90 days due to the fault of the Seller, Seller shall be subject to the liquidated damages provisions in the Procurement Agreement. The issue of fault will be determined by the Engineer.

ARTICLE 5 – TIME OF COMPLETION

5.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedules set forth below, which will be incorporated into Article 5 of the Agreement.

ADD #1

Description:	Proposed Number of Consecutive Calendar Days:
Time required by Seller to submit approvable Shop Drawings (consecutive calendar days after Notice to Proceed is issued to Buyer)	**(maximum of 30 days)**
~~Time required by Seller after receipt of approved Shop Drawings to deliver acceptable Goods to Point of Destination:~~ **Time required by Seller to deliver acceptable Goods to Point of Destination and complete assembly of goods onsite (consecutive calendar days after Notice to Proceed is issued by Buyer).** (consecutive calendar days)	**(maximum of 150 days)**
~~Time required by Seller to complete assembly of goods onsite~~ ~~(exclude time for unloading skids, setting/anchoring skids, making connections to General Contractor process piping, and making connections to Electrical Contractor power)~~	
Time required by Seller to complete all Special Services (consecutive calendar days after notification from Buyer to	50 Days for Start-up & Commissioning 2 Years for Service Contract

Seller to commence such Special Services.):	
Time required by Seller to be ready for Final Inspection and Acceptance of all Goods and all Special Services (consecutive calendar days after notification from Buyer to Seller to commence such Special Services.):	60 Days for Start-up & Commissioning & Performance Testing. 2 Years for Service Contract

5.02 Bidder agrees that the prices in Article 4 above are based on the condition that shipment of goods may be delayed by the Buyer.

ARTICLE 6 – BID DOCUMENTS

6.01 The following documents are attached with and made a condition of this Bid:

A. Attachment 1: Bidder Qualifications

B. Attachment 2: Scope of Supply

C. Attachment 3: OEM Special Services

D. Attachment 4: OEM Warranty

E. Attachment 5: Installation Instructions and Contractor's Responsibilities

F. Attachment 6: Spare Parts

ARTICLE 7 – DEFINED TERMS

7.01 The terms used in this Bid have the meanings indicated in the General Conditions. The significance of terms with initial capital letters is described in the General Conditions.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #1

ARTICLE 8 – BID SUBMITTAL

8.01 This Bid is submitted by:

If Bidder is:

A Partnership

Partnership Name: _____

By: _____
(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed): _____

A Corporation

Corporation Name: Wigen Water Technologies (SEAL)

State of Incorporation: Minnesota
Type (General Business, Professional, Service, Limited Liability): _____

By: Jeff W. Wigen
(Signature -- attach evidence of authority to sign)

Name (typed or printed): Jeff Wigen

Title: President and CEO
(CORPORATE SEAL)

Attest _____

Date of Qualification to do business in Ohio is ___/___/___2011

A Joint Venture

Name of Joint Venture: _____

First Joint Venturer Name: _____(SEAL)

By: _____
(Signature of first joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Second Joint Venturer Name: _____(SEAL)

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By: _____
(Signature of second joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

Bidder's Business Address 302 Lake Hazeltine Drive, Chaska, MN 55318

Phone No. 312-833-3136 Fax No. _____

E-mail eric.geibel@wigen.com

SUBMITTED on May 18, 2020.

END OF SECTION 00 4113

Water.
Process.
Solutions.

Attachment 2: **Scope of Supply**

WIGEN Since 1965 WATER TECHNOLOGIES A Metawater Company

Water. Process. Solutions.

PROPOSAL FOR:

WARREN COUNTY WATER & SEWER DEPARTMENT

MEMBRANE EQUIPMENT PROCUREMENT

SUBMITTED BY:

ERIC GEIBEL, VP BUSINESS DEVELOPMENT

eric.geibel@wigen.com

(312) 833-3136

ISSUED DATE | 18 MAY 2020

PROPOSAL NUMBER | P05182020-203A

Water.
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Solutions.

OUR MANUFACTURERS REPRESENTATIVE:

SULLIVAN ENVIRONMENTAL TECHNOLOGIES
MR. DAN SULLIVAN – (513) 515-6253
dan@sullivanenvtec.com
MR. WENDELL SMITLEY – (614) 395-7379
wendell@sullivanenvtec.com

WIGEN Since 1965 WATER TECHNOLOGIES

Water.
Process.
Solutions.

Table of **Contents**

Water. Process. Solutions.

About Us

History & Background

Founded in 1965, Wigen has evolved from a manufacturer's representative firm into a global leader of custom water treatment and purification systems. With several U.S. patents to its credit, Wigen continues to develop new methods aimed at recycling and recovering our most precious resource.

Wigen has fully integrated production and fabrication capabilities; outsourcing only blasting, painting and electropolishing services. Supported by teams of software developers, and mechanical, electrical and chemical engineers. Wigen's manufacturing group includes metalworking, welding, panel-building, pipefitting, cleanroom assembly, general fabrication and testing operations.

Our headquarters are located near Minneapolis, Minnesota, with operations in Chicago, Denver, New York, and Phoenix. Wigen currently markets to customers throughout North America, Europe and Asia.

Vision

Pacing our stride to become the most trusted name in water treatment.

Mission

To be a recognized leader in products, services and solutions that transform the way water is treated, utilized, reused and distributed.

Values

Integrity – Communicate openly.
Satisfaction – Be responsive.
Ownership – Be empowered.
Teamwork – Support others.
Commitment – Stay focused.
Results – Provide value.
Flexibility – Embrace change.
Relationships – Build bridges.

"It's hard enough to win the first time. If the customer isn't satisfied, there won't be a second time."

- Jeff Wigen, President & CEO

Water.
Process.
Solutions.

Letter from the **CEO**

Dear Customer,

On behalf of all of us at Wigen Water Technologies, I want to personally thank you for the opportunity to provide this proposal for the WCWSD Membrane Equipment Procurement Bid. Our engineering team has carefully reviewed the drawings and specifications to be certain we fully understand the project scope. We recognize that details matter, and it starts with interpreting the requirements and carefully detailing our offer. Thus, you can be confident that our proposal identifies exactly what we intend to furnish, so as to reduce the prospect of expensive unknowns.

Since 1965, we have designed, built, and supported systems like that which is specified for this project. We literally have thousands of successful installations worldwide, including those for demanding markets such as municipal drinking water, nuclear power, desalination, oil & gas, etc. To be a recognized leader in this field , and have been in business for over 50 years, customer satisfaction is paramount. We're only as good as our last project, which is why quality is vitally important to client happiness.

To prove that being best-in-class truly matters, we've invested heavily in a comprehensive ISO 9001 quality management system. This requires action and accountability…all the time. We have very high standards for ourselves, because we know that contractors and end users expect nothing less.

I've grown up in the water business and continue to be involved with the day-to-day operations of the company, just as I have for the last 25 years. I say this because, as a consumer myself, I always feel better about a buying decision, knowing that the principal is actively involved in the business. While our phones are answered live 24/7/365, and our team takes great pride in serving our clients, I'm always available to help make certain your expectations have been met.

We hope to earn your business, and welcome the prospect of making this a successful project!

Sincerely

Jeff W. Wigen

Jeff W. Wigen
President & CEO
Wigen Water Technologies

Your Project **Team**

The following members of our organization will be involved with the design, development and deployment of your project:

SALESPERSON - Mr. Eric Geibel, V.P. Business Development

With a B.S. in Business Administration from Clarkson University in 2002, Eric began his career in the water industry as a Sales Engineer at Pall. By 2007, he had become a technical expert for Pall's Aria MF/UF platforms, and managed sales representatives throughout the Western U.S. In 2008, Eric moved to Pall's office in Australia, where in 2012, he came National Sales Manager. With a desire to come back to the U.S., Eric began working for Veolia in 2013, selling evaporation and crystallization systems in Chicago. He joined Wigen in 2015, to return to his love of selling mainstream clean water technologies; with a particular interest in membrane treatment.

PRINCIPAL ENGINEER - Mr. Stacey Bickler, Director of Engineering

Mr. Bickler holds a B.S. in Chemical Engineering from the University of Minnesota. He began his career in the water field in 1999, as an applications engineer for GE Water Technologies. Within two years, he was promoted to project engineer in the phase-3 group, which included the custom equipment team. Mr. Bickler was the lead engineer for several large municipal projects including Clearwater, FL, Brazos River Authority – Granbury, TX, Gila Bend, AZ, Torrington, WY and Bonita Springs, FL to name a few. Mr. Bickler joined Wigen in 2003, and oversees all facets of daily operations, along with serving as the director of the Quality Management team.

PROCESS ENGINEER - Mr. Brandon Coombs, Project Engineer

Brandon became a member of the Wigen team in 2015, after having spent several years in various engineering roles at RWL Water. He obtained degrees in both chemistry and chemical engineering, from the University of Minnesota. Before beginning his career in the water field, he worked for 3M in its fire protection products laboratory. Brandon brings a great deal of unique experience to the engineering group at Wigen.

PROGRAMMING - Mr. Tim Bjornberg, Automation Engineer

Tim joined Wigen in 2011 after a successful tenure at Beef Products, Inc. in South Sioux City, Nebraska, where he worked as a master I&C engineer. He was responsible for managing the operation of sophisticated production equipment for six U.S. meat processing facilities, and has extensive experience with PLC & HMI programming. In the last five years, Tim has been involved with the commissioning activities of a wide variety high profile projects with Wigen.

MECHANICAL - Mr. Matt Harmon, Mechanical Designer

Mr. Harmon joined Wigen in 2010, after working several years as an instrument and controls technician in the power industry. He brings with him, considerable mechanical aptitude, outstanding troubleshooting skills and excellent knowledge of machine instrumentation. As part of the engineering team, Matt creates designs, develops bills of materials and does 3D CAD drawings.

PRODUCTION - Mr. Matt Keehan, Production Manager

Matt graduated in 2001, with a technical diploma in welding from Wisconsin Technical College. He began his career with Bassett Mechanical in Kaukauna, WI, where he obtained his 6G pipe certification. Mr. Keehan started with Wigen in 2011 as a TIG welder, and became an AWS Certified Welding Inspector, before transitioning to the position of Production Manager. He oversees all aspects of Wigen's production floor operations, including safety, workflow and product testing.

PROCUREMENT - Ms. Angela Christoffer, Purchasing Manager

Ms. Christoffer began her water career in 2005, by joining GE in a customer service role, within the custom equipment division. She eventually ascended to a management position, overseeing the flow of materials and resources allocated for projects. After her department was relocated from Minnesota to Canada, she joined Wigen as a project manager in 2013. Today, she is a vital link between vendors, customers and the production process.

CUSTOMER SERVICE - Ms. Andrea Kroska, Customer Care Coordinator

Andrea was hired in 2015, to bring her vast experience in managing and coordinating service activities. She obtained her Associate of Science degree in Contemporary Business from Inver Hills College, and has worked in a variety service related leadership roles throughout her career. Her current responsibilities include coordinating the schedules of the field service group and interfacing with clients seeking support.

TECHNICAL SUPPORT – Mr. Mark Roufs, Aftermarket Services Manager

Prior to joining Wigen in 2012, Mr. Roufs spent 21 years at Culligan, where he worked as a field service engineer for 15 years, followed by 6 years in industrial sales. His responsibility at Wigen, is to help ensure existing customers have access to the full breadth of technical support options. More specifically, Mr. Roufs ultimately handles inbound support inquiries and either addresses them himself or engages the help of other internal technical resources.

Basis of Design

RARWTP Expected Water Quality

Table 1 – RARWTP Water Quality Data

Parameter	Unit	Raw Water	Permeate Requirements
NH4+ +NH3	mg/L	0.00	
K	mg/L	2.9	
Na	mg/L	33	
Mg	mg/L	27	
Ca	mg/L	102	
TH	mg/L as CaCO3	366	< 15
Sr	mg/L	0.33	
Ba	mg/L	0.10	
CO3	mg/L	0.27	
HCO3	mg/L	310	
NO3	mg/L	0.56	
Cl	mg/L	63	< 10
F	mg/L	0.20	
SO4	mg/L	52.00	> 0.40
SiO2	mg/L	6.30	
Boron	mg/L	0.00	
TDS	mg/L	597.56	< 30
pH	s.u.	7.11	
Temperature	Degrees F	55-60	

FAWTP Expected Water Quality

Table 2 – FAWTP Water Quality Data

Parameter	Unit	Raw Water	Permeate Requirements
NH4+ +NH3	mg/L	0.00	
K	mg/L	3.0	
Na	mg/L	17	
Mg	mg/L	27	
Ca	mg/L	71	
TH	mg/L as CaCO3	288	< 10
Sr	mg/L	0.75	
Ba	mg/L	0.06	
CO3	mg/L	0.50	
HCO3	mg/L	256	
NO3	mg/L	2.4	
Cl	mg/L	34	< 5
F	mg/L	0.21	
SO4	mg/L	29	> 0.20
SiO2	mg/L	7.7	
Boron	mg/L	0.00	
TDS	mg/L	449	< 25
pH	s.u.	7.5	
Temperature	Degrees F	55-60	

Detailed Scope of **Supply**

WIGEN Since 1965 WATER TECHNOLOGIES

Water. Process. Solutions.

RARWTP Scope of **Supply**

Richard A. Renneker WTP (RARWTP)

Nanofiltration Membrane Equipment Scope of Supply:

NF Skid Design	Unit	Data
Number of NF Skids	No.	6
NF Membrane Modules	No.	DOW NF90
Configuration		2 Stage, 24:12, 7 long
Permeate Capacity	gpm	1030
Recovery Rate	%	80% (adjustable from 70% to 83%)
Flux	Gfd	14.7

Membrane Pressure Vessels	
Vessel Quantity	36 Per Train
Manufacturer / Model	Wave Cyber, WAVE-300P-8
Vessel Construction	FRP, 300 psig
Sample Ports	¼" sample valves
NF/RO Skids	
Skid Quantity	(6) with 36 housings per skid
Construction	Powder Coated Carbon Steel (Stainless Option Provided)
Dimensions (W x L x H) – approx.	95"x318"x150" (Approx. Dimensions)
Piping Materials	
NF Skid Inlet	Schedule 10 316 Stainless Steel
NF Skid Permeate	Schedule 80 PVC
NF Skid High Pressure Concentrate	Schedule 10 316 Stainless Steel
NF Skid Low Pressure Concentrate	Schedule 80 PVC

RARWTP NF SYSTEM SCOPE CONT'D

NF System Valves – All mounted on NF Skid	
NF Feed Valve	One (1) per skid, 10" Bray Series 41 Butterfly Valve w/ Bray Series 93 pneumatic actuator and Bray Series 54 prox. switch
NF Feed Isolation Valve	One (1) per skid, 10" Bray Series 41 Butterfly Valve w/ HWGO
NF Feed Drain Valve	One (1) per skid, 1.5" Flow-Tek S40 316SS Ball Valve w/ Lever
1st Stage Cleaning Solution Feed Isolation	One (1) per skid, 8" Bray Series 41 Butterfly Valve w/ HWGO
Cleaning Solution Feed Isolation Valve	One (1) per skid, 8" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
Cleaning Solution Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
1st Stage Cleaning Solution Concentrate Return Isolation Valve	One (1) per skid, 8" Bray Series 41 Butterfly Valve w/ HWGO
1st Stage Cleaning Solution Concentrate Return Block Valve	One (1) per skid, 6" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
1st Stage Cleaning Solution Concentrate Return Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
1st Stage Concentrate Air Release Isolation Valve	One (1) per skid, 0.5" Flow-Tek S40 316SS Ball Valve w/ Lever
2nd Stage Feed Isolation Valve	One (1) per skid, 6" Bray Series 41 Butterfly Valve w/ HWGO
2nd Stage Cleaning Solution Feed Isolation	One (1) per skid, 6" Bray Series 41 Butterfly Valve w/ HWGO
2nd Stage Concentrate Drain Valve	One (1) per skid, 1.0" Flow-Tek S40 316SS Ball Valve w/ Lever
Concentrate Throttling Valve	One (1) per skid, 3" Warren Controls Globe Valve, w/ AUMA 120VAC modulating electric actuator with position feedback
Concentrate Flush/Bypass Valve	One (1) per skid, 4" Bray Series 41 Butterfly Valve, with Bray Series 93 pneumatic actuator and Bray Series 54 prox. switch
2nd Stage Concentrate Check Valve	One (1) per skid, 4" Ritepro 210 Series 316SS Wafer Check Valve
Final Concentrate Isolation Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
1st Stage Permeate Throttling Valve	One (1) per skid, 6" Flow-Tek V-Port Ball Valve w/ AUMA 120VAC modulating electric actuator with position feedback
1st Stage Permeate Isolation	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ HWGO
2nd Stage Permeate Isolation	One (1) per skid, 6" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ HWGO

Final Permeate Check Valve	One (1) per skid, 8" Ritepro 210 Series 316SS Wafer Check Valve
Final Permeate Isolation	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ Bray Series 93 pneumatic actuator and Bray Series 54 prox. switch
Final Permeate Isolation	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ HWGO
Final Permeate Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
Permeate Dump Valve	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ Bray Series 93 pneumatic actuator and Series 54 prox. switch
Cleaning Solution Permeate Return Isolation Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
Cleaning Solution Permeate Return Block Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
Cleaning Solution Permeate Return Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
Final Concentrate / 1st Stage CSCCR Interconnect Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
1st Stage Concentrate Air Release Valve	One (1) per skid, 0.5" Valmatic Air Release Valve, Series 15A
Sampling Valves	(42) per skid, Feed, Interstage, Concentrate, 1st Stage Permeate, 2nd Stage Permeate, Combined Permeate, each Housing Permeate– ¼" Labcock Valves, Panel Mounted
Pressure Vessel Permeate Probe	(36) per skid – ¼" Labcock Valves, end of Pressure vessels

RARWTP NF SYSTEM INSTRUMENTS

Conductivity Sensors	
Quantity	(4) Per Train – Feed, 1st Stage Permeate, 2nd Stage Permeate, Total Permeate
Manufacturer / Model	Rosemount 402VP with Retraction Assembly
Feed ORP Meter	
Quantity	(1) Per Train
Manufacturer / Model	Rosemount 389VP with Panel Mounted Low Flow Cell
Analytical Transmitter	
Quantity	(3) Per Train
Manufacturer / Model	Rosemount 1056 2-Channel Transmitter
Mag Flow Meters	
Quantity	(3) Per Train – Feed, Interstage, Concentrate
Manufacturer / Model	Siemens 5100 Series Magnetic Flow Meter with Remote Transmitter
Pressure Transmitters / Switches	
Quantity	(5) Per Train – Feed, Interstage, Concentrate, Stage 1 Permeate, Final Permeate
Manufacturer / Model	United Electric Controls, One Series
Pressure Gauges	
Quantity	(4) Per Train – NF Control Panel, Concentrate, 1st Stage Permeate, Final Permeate
Manufacturer / Model	Ashcroft / 4.5” 1279 Duragauge, Panel Mounted
Loose Differential Pressure Transmitters	
Quantity	(2) For Degasifier Blower Intakes
Manufacturer / Model	United Electric Controls, One Series
Loose Paddlewheel Flow Meter	
Quantity	(1) – Downstream of Cartridge Filters
Manufacturer / Model	8” Seametrics IP800 Series

WIGEN Since 1965 WATER TECHNOLOGIES

Water. Process. Solutions.

RARWTP UTILITY REQUIREMENTS & CONNECTIONS (by contractor, Each Skid)

NF Feed Inlet	10” 150# RF Flange
MCS Inlet	8” 150# RF Flange
Permeate Dump	8” 150# RF Flange
Permeate to Clearwell	8” 150# RF Flange
Permeate to CIP	4” 150# RF Flange
Concentrate to Waste	4” 150# RF Flange
Concentrate to CIP	8” 150# RF Flange
Sample Trough Drain	2.0” FNPT
Power Requirements	120 V / 1 Phase / 60 HZ / 15 A
Instrument Air Inlet	0.5” FNPT, 1 CFM @ 80 PSI Minimum

ITEMS TO BE SUPPLIED BY OTHERS

- Communications wiring from all RO skid Control Panels to the Master PLC/SCADA System.
- Power wiring to all PLC Panels and Remote I/O panels.
- Off-loading and installation of the skid systems and loose items (including membranes) required for full operation of the system.
- Installation of piping between skids.
- Air piping for instrument air to all skids.
- Skid Anchor Bolts.

RARWTP CIP System

CIP Tank Instruments (Loose)	
Tank Level Control	(4) Level Switches – ITT Flygt ENM-10
CIP Tank Heater (Loose)	
Quantity	Two (2) One Per Tank
Manufacturer	Chromolox,
Type / Size	Flanged Immersion / 120 kW, 75kW
CIP pH Sensor (Loose)	
Quantity	Two (2) One Per Tank
Manufacturer / Model	Rosemount 389VP
Analytical Transmitter (Loose)	
Quantity	One (1)
Manufacturer / Model	Rosemount 1056 2-Channel Transmitter
CIP Temperature Gauge (Loose)	
Manufacturer / Model	Wika TI30
Controls/Electrical (Loose)	
Local Control Panel	MCS Remote I/O Control Panel

CIP ITEMS TO BE SHIPPED "LOOSE"

- CIP Tank Level Instruments
- CIP pH Instruments and Transmitter
- CIP Temperature Indicator
- CIP Tank Heaters

Water. Process. Solutions.

RARWTP NF System Controls: Wigen Water Technologies will provide a new ControlLogix PLC system to control the Nanofiltration (NF) system housed in the NF Main PLC Control Panel. Each NF skid and the Membrane Cleaning System (MCS) skid will be supplied with a ControlLogix Ethernet remote I/O rack along with a 15" PanelView Plus 7 operator interface. Each control panel will be supplied with a minimum of 10% spare I/O points as well as adequate space to add I/O modules if required. Skid mounted control panels will be factory wired to devices on the skids. Wiring between the NF Main PLC Control Panel and remote I/O panels and to any field mounted or loose supplied devices is to be by others. Motor controls (VFDs, starters, etc.) will be controlled from the NF system. The control panels and main components being supplied are detailed below.

Main PLC/HMI Control Panel Features: Supplied loose for installation by contractor

(1) NF Main PLC Control Panel (PLC-NF)
• (1) Saginaw NEMA 4X 304 Stainless Steel Wall-Mount Enclosure
  o Approximate Dimensions: 90x36x24
• (1) Saginaw Enclosure Sub Panel
• (1) Saginaw SCE Series Enclosure Heater
• (4) Hoffman AHCI Series Corrosion Inhibitor
• (1) Saginaw Enclosure LED Light Kit
• (1) Liebert GXT5 Series Uninterruptable Power Supply
• (1) Phoenix Contact 120VAC 480W Power Supply
• (1) Allen-Bradley ControlLogix PLC System
  o (1) Allen-Bradley 1756-A17 Chassis
  o (1) Allen-Bradley 1756-PA75/B Power Supply
  o (1) Allen-Bradley 1756-L81E Processor
  o (5) Allen-Bradley 1756-N2 Slot Filler Module
  o (2) Allen-Bradley 1756-IA16I 16-Point Digital Input Module
  o (1) Allen-Bradley 1756-OW16I 16-Point Digital Output Module
• (1) Stratix 5700, 10-Port Managed Ethernet Switch
• (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks
• (LOT) Din Rail, Wireway, Etc.
• All I/O and Relay Contacts Wired to Terminal Blocks
• Supplied Loose for Contractor Installation

RARWTP NF SYSTEM CONTROLS CONT'D

(6) NF Remote I/O Control Panel

- (1) Saginaw NEMA 4X 304 Stainless Steel Wall-Mount Enclosure
  - Approximate Dimensions: 48x36x12
- (1) Saginaw Enclosure Sub Panel
- (1) Saginaw SCE Series Enclosure Heater
- (1) Saginaw Enclosure LED Light Kit
- (4) Hoffman AHCI Series Corrosion Inhibitor
- (1) Liebert GXT5 Series Uninterruptable Power Supply
- (1) Phoenix Contact 120VAC 480W Power Supply
- (1) Allen-Bradley ControlLogix Ethernet Remote I/O System
  - (1) Allen-Bradley 1756-EN2TR Ethernet Communication Module
  - (1) Allen-Bradley 1756-A17 Chassis
  - (1) Allen-Bradley 1756-PA75/B Power Supply
  - (1) Allen-Bradley 1756-IA16I 16-Point Digital Input Module
  - (1) Allen-Bradley 1756-OW16I 16-Point Digital Output Module
  - (3) Allen-Bradley 1756-IF8I 8-Point Analog Input Module
  - (1) Allen-Bradley 1756-OF8I 8-Point Analog Output Module
  - (3) Allen-Bradley 1756-N2 Slot Filler Module
- (1) Allen-Bradley PanelView Plus 7 Series 15" Operator Interface
- (4) Numatics 501 Series Solenoid Valves for Valve Actuation
- (1) Stratix 5700, 10-Port Managed Ethernet Switch
- (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks
- (LOT) Fuses, Din Rail, Wireway, Etc.
- All I/O and Relay Contacts Wired to Terminal Blocks
- Supplied Installed on NF Skids

RARWTP NF SYSTEM CONTROLS CONT'D

(1) MCS Remote I/O Control Panel: Supplied Loose for Installation by Contractor

• (1) Saginaw NEMA 4X 304 Stainless Steel Wall-Mount Enclosure
  o Approximate Dimensions: 48x36x12
• (1) Saginaw Enclosure Sub Panel
• (1) Saginaw SCE Series Enclosure Heater
• (1) Saginaw Enclosure LED Light Kit
• (4) Hoffman AHCI Series Corrosion Inhibitor
• (1) Liebert GXT5 Series Uninterruptable Power Supply
• (1) Phoenix Contact 120VAC 480W Power Supply
• (1) Allen-Bradley ControlLogix Ethernet Remote I/O System
  o (1) Allen-Bradley 1756-EN2TR Ethernet Communication Module
  o (1) Allen-Bradley 1756-A17 Chassis
  o (1) Allen-Bradley 1756-PA75/B Power Supply
  o (2) Allen-Bradley 1756-IA16I 16-Point Digital Input Module
  o (1) Allen-Bradley 1756-OW16I 16-Point Digital Output Module
  o (1) Allen-Bradley 1756-IF8I 8-Point Analog Input Module
  o (3) Allen-Bradley 1756-N2 Slot Filler Module
• (1) Allen-Bradley PanelView Plus 7 Series 15" Operator Interface
• (1) Stratix 5700, 10-Port Managed Ethernet Switch
• (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks
• (LOT) Fuses, Din Rail, Wireway, Etc.
• All I/O and Relay Contacts Wired to Terminal Blocks

(1) MSC Motor Control: Provided Loose for Contractor Installation
• (2) 60HP Allen-Bradley Powerflex 753 VFDs • (1) 210A Allen-Bradley Motor Contactor for Stage 1 Immersion Heater • (1) 140A Allen-Bradley Motor Contactor for Stage 2 Immersion Heater • (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks • (LOT) Fuses, Din Rail, Wireway, Etc. • All Relay Contacts Wired to Terminal Blocks

FAWTP Scope of **Supply**

Franklin Area Water Treatment Plant (FAWTP)

Nanofiltration Membrane Equipment Scope of Supply:

NF Skid Design	Unit	Data
Number of NF Skids	No.	3
NF Membrane Modules	No.	DOW NF90
Configuration		2 Stage, 27:14, 7 long
Permeate Capacity	gpm	1198
Recovery Rate	%	80% (adjustable from 70% to 83%)
Flux	Gfd	15

Membrane Pressure Vessels	
Vessel Quantity	41 Per Train
Manufacturer / Model	Wave Cyber, WAVE-300P-8
Vessel Construction	FRP, 300 psig
Sample Ports	¼" sample valves
NF/RO Skids	
Skid Quantity	(3) with 41 housings per skid
Construction	Powder Coated Carbon Steel (Stainless Option Provided)
Dimensions (W x L x H) – approx.	95"x318"x150" (Approx. Dimensions)
Piping Materials	
NF Skid Inlet	Schedule 10 316 Stainless Steel
NF Skid Permeate	Schedule 80 PVC
NF Skid High Pressure Concentrate	Schedule 10 316 Stainless Steel
NF Skid Low Pressure Concentrate	Schedule 80 PVC

FAWTP NF SYSTEM SCOPE CONT'D

NF System Valves – All mounted on NF Skid	
NF Feed Valve	One (1) per skid, 10" Bray Series 41 Butterfly Valve w/ Bray Series 93 pneumatic actuator and Bray Series 54 prox. switch
NF Feed Isolation Valve	One (1) per skid, 10" Bray Series 41 Butterfly Valve w/ HWGO
NF Feed Drain Valve	One (1) per skid, 1.5" Flow-Tek S40 316SS Ball Valve w/ Lever
Permeate Flush Isolation Valve	One (1) per skid, 10" Bray Series 41 Butterfly Valve w/ Bray Series 93 pneumatic actuator and Bray Series 54 prox. switch
Permeate Flush Drain Valve	One (1) per skid, 1.5" Flow-Tek S40 316SS Ball Valve w/ Lever
1st Stage Cleaning Solution Feed	One (1) per skid, 8" Bray Series 41 Butterfly Valve w/ HWGO
Cleaning Solution Feed Isolation Valve	One (1) per skid, 8" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
Cleaning Solution Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
1st Stage Cleaning Solution Concentrate Return Isolation Valve	One (1) per skid, 8" Bray Series 41 Butterfly Valve w/ HWGO
1st Stage Cleaning Solution Concentrate Return Block Valve	One (1) per skid, 6" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
1st Stage Cleaning Solution Concentrate Return Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
1st Stage Concentrate Air Release Isolation Valve	One (1) per skid, 0.5" Flow-Tek S40 316SS Ball Valve w/ Lever
2nd Stage Feed Isolation Valve	One (1) per skid, 6" Bray Series 41 Butterfly Valve w/ HWGO
2nd Stage Cleaning Solution Feed Isolation	One (1) per skid, 6" Bray Series 41 Butterfly Valve w/ HWGO
2nd Stage Concentrate Drain Valve	One (1) per skid, 1.0" Flow-Tek S40 316SS Ball Valve w/ Lever
Concentrate Throttling Valve	One (1) per skid, 3" Warren Controls Globe Valve, w/ AUMA 120VAC modulating electric actuator with position feedback
Concentrate Flush/Bypass Valve	One (1) per skid, 4" Bray Series 41 Butterfly Valve, with Bray Series 93 pneumatic actuator and Bray Series 54 prox. switch
2nd Stage Concentrate Check Valve	One (1) per skid, 4" Ritepro 210 Series 316SS Wafer Check Valve
Final Concentrate Isolation Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
1st Stage Permeate Throttling Valve	One (1) per skid, 6" Flow-Tek V-Port Ball Valve w/ AUMA 120VAC modulating electric actuator with position feedback
1st Stage Permeate Isolation Valve	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ HWGO
2nd Stage Permeate Isolation Valve	One (1) per skid, 6" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ HWGO

FAWTP NF SYSTEM SCOPE CONT'D

Final Permeate Check Valve	One (1) per skid, 8" Ritepro 210 Series 316SS Wafer Check Valve
Final Permeate Isolation Valve	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ Bray Series 93 pneumatic actuator and Bray Series 54 prox. switch
Final Permeate Block Valve	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ HWGO
Final Permeate Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
Permeate Dump Valve	One (1) per skid, 8" Bray Series 31 Butterfly Valve, Nylon 11 coated w/ Bray Series 93 pneumatic actuator and Series 54 prox. switch
Cleaning Solution Permeate Return Isolation Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
Cleaning Solution Permeate Return Block Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
Cleaning Solution Permeate Return Bleed Valve	One (1) per skid, 0.5" Hayward TBH Series PVC Ball Valve w/ Handle Operator
Final Concentrate / 1st Stage CSCCR Interconnect Valve	One (1) per skid, 4" Hayward BYV Series PVC Butterfly Valve, w/ HWGO
1st Stage Concentrate Air Release Valve	One (1) per skid, 0.5" Valmatic Air Release Valve, Series 15A
Sampling Valves	(47) per skid, Feed, Interstage, Concentrate, 1st Stage Permeate, 2nd Stage Permeate, Combined Permeate, each Housing Permeate– ¼" Labcock Valves, Panel Mounted
Pressure Vessel Permeate Probe	(41) per skid – ¼" Labcock Valves, end of Pressure vessels

FAWTP NF SYSTEM INSTRUMENTS

Conductivity Sensors	
Quantity	(4) Per Train – Feed, 1st Stage Permeate, 2nd Stage Permeate, Total Permeate
Manufacturer / Model	Rosemount 402VP with Retraction Assembly
Feed ORP Meter	
Quantity	(1) Per Train
Manufacturer / Model	Rosemount 389VP with Panel Mounted Low Flow Cell
Analytical Transmitter	
Quantity	(3) Per Train
Manufacturer / Model	Rosemount 1056 2-Channel Transmitter
Mag Flow Meters	
Quantity	(3) Per Train – Feed, Interstage, Concentrate
Manufacturer / Model	Siemens 5100 Series Magnetic Flow Meter with Remote Transmitter
Pressure Transmitters / Switches	
Quantity	(5) Per Train – Feed, Interstage, Concentrate, Stage 1 Permeate, Final Permeate
Manufacturer / Model	United Electric Controls, One Series
Pressure Gauges	
Quantity	(4) Per Train – NF Control Panel, Concentrate, 1st Stage Permeate, Final Permeate
Manufacturer / Model	Ashcroft / 4.5” 1279 Duragauge, Panel Mounted
Loose Paddlewheel Flow Meter	
Quantity	(1) – Downstream of Cartridge Filters
Manufacturer / Model	8” Seametrics IP800 Series

FAWTP UTILITY REQUIREMENTS & CONNECTIONS (by contractor, Each Skid)

NF Feed Inlet	10” 150# RF Flange
MCS Inlet	8” 150# RF Flange
Permeate Dump	8” 150# RF Flange
Permeate to Clearwell	8” 150# RF Flange
Permeate to CIP	4” 150# RF Flange
Concentrate to Waste	4” 150# RF Flange
Concentrate to CIP	8” 150# RF Flange
Sample Trough Drain	2.0” FNPT
Power Requirements	120 V / 1 Phase / 60 HZ / 15 A
Instrument Air Inlet	0.5” FNPT, 1 CFM @ 80 PSI Minimum

ITEMS TO BE SUPPLIED BY OTHERS

- Communications wiring from all RO skid Control Panels to the Master PLC/SCADA System.
- Power wiring to all PLC Panels and Remote I/O panels.
- Off-loading and installation of the skid systems and loose items (including membranes) required for full operation of the system.
- Installation of piping between skids.
- Air piping for instrument air to all skids.
- Skid Anchor Bolts.

FAWTP CIP System

CIP Tank Instruments (Loose)	
Tank Level Control	(4) Level Switches – ITT Flygt ENM-10
CIP Tank Heater (Loose)	
Quantity	Two (2) One Per Tank
Manufacturer	Chromolox,
Type / Size	Flanged Immersion / 120 kW, 75kW
CIP pH Sensor (Loose)	
Quantity	Two (2) One Per Tank
Manufacturer / Model	Rosemount 389VP
Analytical Transmitter (Loose)	
Quantity	One (1)
Manufacturer / Model	Rosemount 1056 2-Channel Transmitter
CIP Temperature Gauge (Loose)	
Manufacturer / Model	Wika TI30
Controls/Electrical (Loose)	
Local Control Panel	MCS Remote I/O Control Panel

FAWTP CIP SYSTEM CONT'D

CIP ITEMS TO BE SHIPPED "LOOSE"

- CIP Tank Level Instruments
- CIP pH Instruments and Transmitter
- CIP Temperature Indicator
- CIP Tank Heaters

FAWTP PERMEATE FLUSH SYSTEM

Permeate Flush Tank Level Transmitter (Loose)	
Quantity	One (1)
Manufacturer / Model	Dwyer Instruments – PBLT2

PERMEATE FLUSH ITEMS TO BE SHIPPED "LOOSE OR BY OTHERS"

- Permeate Flush Tank Level Transmitter

FAWTP NF System Controls: Wigen Water Technologies will provide a new ControlLogix PLC system to control the Nanofiltration (NF) system housed in the NF Main PLC Control Panel. Each NF skid and the Membrane Cleaning System (MCS) skid will be supplied with a ControlLogix Ethernet remote I/O rack along with a 15" PanelView Plus 7 operator interface. Each control panel will be supplied with a minimum of 10% spare I/O points as well as adequate space to add I/O modules if required. Skid mounted control panels will be factory wired to devices on the skids. Wiring between the NF Main PLC Control Panel and remote I/O panels and to any field mounted or loose supplied devices is to be by others. Motor controls (VFDs, starters, etc.) will be controlled from the NF system. The control panels and main components being supplied are detailed below.

(1) Main PLC/HMI Control Panel Features: Supplied loose for installation by contractor

- (1) Saginaw NEMA 4X 304 Stainless Steel Wall-Mount Enclosure
  - Approximate Dimensions: 90x36x24
- (1) Saginaw Enclosure Sub Panel
- (1) Saginaw SCE Series Enclosure Heater
- (4) Hoffman AHCI Series Corrosion Inhibitor
- (1) Saginaw Enclosure LED Light Kit
- (1) Liebert GXT5 Series Uninterruptable Power Supply
- (1) Phoenix Contact 120VAC 480W Power Supply
- (1) Allen-Bradley ControlLogix PLC System
  - (1) Allen-Bradley 1756-A17 Rack
  - (1) Allen-Bradley 1756-PA75/B Power Supply
  - (1) Allen-Bradley 1756-L81E Processor
  - (5) Allen-Bradley 1756-N2 Slot Filler Module
  - (2) Allen-Bradley 1756-IA16I 16-Point Digital Input Module
  - (1) Allen-Bradley 1756-OW16I 16-Point Digital Output Module
- (1) Stratix 5700, 10-Port Managed Ethernet Switch
- (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks
- (LOT) Din Rail, Wireway, Etc.
- All I/O and Relay Contacts Wired to Terminal Blocks
- Supplied Loose for Contractor Installation

FAWTP NF SYSTEM CONTROLS CONT'D

(3) NF Remote I/O Control Panel

- (1) Saginaw NEMA 4X 304 Stainless Steel Wall-Mount Enclosure
  - Approximate Dimensions: 48x36x12
- (1) Saginaw Enclosure Sub Panel
- (1) Saginaw SCE Series Enclosure Heater
- (1) Saginaw Enclosure LED Light Kit
- (4) Hoffman AHCI Series Corrosion Inhibitor
- (1) Liebert GXT5 Series Uninterruptable Power Supply
- (1) Phoenix Contact 120VAC 480W Power Supply
- (1) Allen-Bradley ControlLogix Ethernet Remote I/O System
  - (1) Allen-Bradley 1756-EN2TR Ethernet Communication Module
  - (1) Allen-Bradley 1756-A17 Chassis
  - (1) Allen-Bradley 1756-PA75/B Power Supply
  - (2) Allen-Bradley 1756-IA16I 16-Point Digital Input Module
  - (1) Allen-Bradley 1756-OW16I 16-Point Digital Output Module
  - (3) Allen-Bradley 1756-IF8I 8-Point Analog Input Module
  - (1) Allen-Bradley 1756-OF8I 8-Point Analog Output Module
  - (3) Allen-Bradley 1756-N2 Slot Filler Module
- (1) Allen-Bradley PanelView Plus 7 Series 15" Operator Interface
- (4) Numatics 501 Series Solenoid Valves for Valve Actuation
- (1) Stratix 5700, 10-Port Managed Ethernet Switch
- (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks
- (LOT) Fuses, Din Rail, Wireway, Etc.
- All I/O and Relay Contacts Wired to Terminal Blocks
- Supplied Installed on NF Skids

FAWTP NF SYSTEM CONTROLS CONT'D

(1) MCS / Flush Remote I/O Control Panel: Supplied Loose for Installation by Contractor

• (1) Saginaw NEMA 4X 304 Stainless Steel Wall-Mount Enclosure
  o Approximate Dimensions: 48x36x12
• (1) Saginaw Enclosure Sub Panel
• (1) Saginaw SCE Series Enclosure Heater
• (1) Saginaw Enclosure LED Light Kit
• (4) Hoffman AHCI Series Corrosion Inhibitor
• (1) Liebert GXT5 Series Uninterruptable Power Supply
• (1) Phoenix Contact 120VAC 480W Power Supply
• (1) Allen-Bradley ControlLogix Ethernet Remote I/O System
  o (1) Allen-Bradley 1756-EN2TR Ethernet Communication Module
  o (1) Allen-Bradley 1756-A17 Rack
  o (1) Allen-Bradley 1756-PA75/B Power Supply
  o (2) Allen-Bradley 1756-IA16I 16-Point Digital Input Module
  o (1) Allen-Bradley 1756-OW16I 16-Point Digital Output Module
  o (2) Allen-Bradley 1756-IF8I 8-Point Analog Input Module
  o (3) Allen-Bradley 1756-N2 Slot Filler Module
• (1) Allen-Bradley PanelView Plus 7 Series 15" Operator Interface
• (1) Stratix 5700, 10-Port Managed Ethernet Switch
• (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks
• (LOT) Fuses, Din Rail, Wireway, Etc.
• All I/O and Relay Contacts Wired to Terminal Blocks

(1) MSC Motor Control: Provided Loose for Contractor Installation
• (3) 60HP Allen-Bradley Powerflex 753 VFDs • (1) 210A Allen-Bradley Motor Contactor for Stage 1 Immersion Heater • (1) 140A Allen-Bradley Motor Contactor for Stage 2 Immersion Heater • (LOT) Allen-Bradley Circuit Breakers, Relays, Terminal Blocks • (LOT) Fuses, Din Rail, Wireway, Etc. • All Relay Contacts Wired to Terminal Blocks

WIGEN Since 1965 WATER TECHNOLOGIES

Water. Process. Solutions.

Pricing and **Commercial Terms**

PRICING

Pricing provided on Bid Form.

PREFERRED PAYMENT TERMS

PLEASE SEE ATTACHMENT 7: Deducts, Clarifications, Exceptions

PRICING NOTES

- All prices are quoted in USD.
- No sales or value added tax is included.
- The customer will pay all applicable local, state, provincial or federal taxes and duties.
- The equipment delivery date, start date, and date of commencement of operations are to be negotiated.
- This proposal supersedes all previous proposals and correspondence.
- This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order.
- Seller's price and delivery schedule are based on the assumption that Buyer will take delivery as per the agreed delivery schedule in the Agreement. If there is a subsequent change in the schedule, the Parties must agree in advance an alternative place of delivery, failing which the Seller will be entitled to ship the equipment to storage. Buyer shall issue a change order to take into account any additional cost of delay incurred by Seller in implementing this change.

CONDITIONAL OFFERING

Customer understands that this proposal has been issued based upon the information provided by customer, and currently available to WWT at the time of issuing this proposal. Any changes or discrepancies in site conditions, including but not limited to system influent water characteristics, changes in environmental health and safety conditions, Customer financial standing, Customer requirements, or any other relevant change, or discrepancy in, the factual basis upon which this proposal was created, may lead to changes in the offering, including but not limited to changes in pricing, warranties, quoted specifications, or terms and conditions.

Limited Mechanical Equipment **Warranty**

Wigen Companies, Inc., d/b/a Wigen Water Technologies, referred to hereinafter as "WWT," warrants that for a period of 18 months from the date of shipment or 12 months from System Acceptance [whichever occurs sooner] any equipment or other product it manufactures: (1) Will be free of defects in material and workmanship, and, (2) if WWT has recommended or manufactured a specific product based on written plans and specifications or a written statement of requirements provided by Buyer, that the product will be fit for the purpose identified in such written plans, specifications, or statement of requirements; provided, however, that such warranties shall be void if the product is not installed, operated or used in accordance with WWT's written instructions (including, without limitation, installation and operating instructions and manuals). **THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED AND WWT EXPRESSLY DISCLAIMS ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** The foregoing warranties apply only to the original purchaser, and do not extend to any subsequent owner.

WWT'S LIABILITY UPON THE FOREGOING WARRANTIES SHALL BE LIMITED TO, AT WWT'S OPTION, REPAIRING OR REPLACING THE DEFECTIVE EQUIPMENT OR COMPONENTS THEREOF WITHOUT CHARGE, F.O.B. WWT'S FACTORY. Buyer shall provide WWT with reasonable opportunities to make inspections, tests, and repairs using the most cost effective methods available. Without limiting the foregoing, WWT disclaims any and all liability for penalties, special or punitive damages, damages for loss of profits or business, lost revenues, loss of use of the product or any associated equipment, cost of capital, facilities or services, down-time, shut-down or slow-down costs, or any other economic losses or property damage. Buyer shall indemnify WWT against any and all losses, liabilities, damages and expenses (including attorneys' fees or any costs required to defend any legal action) based on defects that are proven not to be the fault or negligence of WWT. WWT will not be liable for damage or wear to products or materials due to or caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, if the product was not installed or applied in accordance with WWT's installation or operating instructions, or, if WWT recommended or manufactured a specific product based on plans and specifications or stated requirements provided by Buyer, if Buyer deviates from the plans and specifications or stated requirements that were provided to WWT. No allowance will be made for repairs or alterations made without WWT's written consent or approval, and any such repairs made without WWT's written consent or approval will render the warranties null and void. No equipment shall be returned to WWT without first obtaining WWT's prior written authorization. If it is determined that WWT is not responsible under the terms of this agreement for any such inspections, tests, repairs or replacements, the Buyer shall pay WWT for such inspections, tests, repairs and replacements at WWT's prevailing rates in effect from time to time.

MEMBRANES AND MEDIA PRODUCTS ARE COVERED BY WWT, BUT ONLY TO THE EXTENT THAT COVERAGE IS OFFERED BY THE ORIGINAL EQUIPMENT MANUFACTURER (OEM) OF SUCH PRODUCTS, AND WWT DOES NOT PROVIDE ANY WARRANTIES OR REMEDIES BEYOND THAT WHICH IS EXPRESSLY STATED IN THE OEM'S OWN WARRANTY DOCUMENTS.

To obtain warranty service for WWT products, the defective product must be returned to WWT together with proof of purchase, installation date, failure date, and supporting technical data. Any defective product returned to the factory must be sent freight prepaid. Documentation supporting the warranty claim and a Returned Material Authorization (RMA) number must be included. Contact your WWT salesperson for details on obtaining a RMA number.

SERVICES: Any services WWT hereafter provides with respect to products purchased from WWT or others, whether directly or through subcontractors, shall be performed in accordance with the standard of care with which such services are normally provided in the industry. If the services fail to meet the applicable industry standard, and WWT receives notice of such failure within 365 days from the date of completion, WWT will re-perform such services at no cost to Buyer. **RE-PERFORMANCE OF SERVICES SHALL BE BUYER'S SOLE AND EXCLUSIVE REMEDY, AND IN NO EVENT WILL WWT BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL OR OTHER DAMAGES (EVEN IF WWT HAS BEEN MADE AWARE OF THE POSSIBILITY OF SUCH DAMAGES), NOR, IN ANY EVENT, SHALL WWT'S WARRANTY OBLIGATIONS WITH RESPECT TO SERVICES EXCEED 100% OF THE TOTAL COST OF THE SERVICES PROVIDED.**

WARRANTY PERIODS: EVERY CLAIM BY BUYER ALLEGING A DEFECT IN ANY GOODS AND/OR SERVICES PROVIDED SHALL BE DEEMED WAIVED UNLESS SUCH CLAIM IS MADE IN WRITING WITHIN THE APPLICABLE WARRANTY PERIOD AS SET FORTH ABOVE. Provided, however, if a defect in any product manufactured by WWT is latent and not discoverable within the warranty period applicable thereto, any claim arising on account of such latent defect shall be deemed waived unless it is made in writing within a reasonable time, not exceeding 30 days, after such latent defect is or should have been discovered by Buyer.

Limitations / Exclusions: The warranties herein shall not apply to, and WWT shall not be responsible for, any damage to the goods or failure of the services supplied hereunder, to the extent caused by Buyer's neglect, failure to follow operational and maintenance procedures, or the use of technicians not specifically authorized by WWT to maintain or service its equipment. Before receiving the final drawings, programming and intangible property provided by WWT, the Owner shall agree in writing, to hold WWT harmless for subpar performance and/or damage to the equipment, related to changes made without the express written consent of WWT. **THE WARRANTIES AND REMEDIES CONTAINED HEREIN ARE IN LIEU OF AND EXCLUDE ALL OTHER WARRANTIES AND REMEDIES, WHETHER EXPRESSED OR IMPLIED BY OPERATION OF LAW OR OTHERWISE, INCLUDING ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A SPECIFIC PURPOSE.**

Water.
Process.
Solutions.

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WIGEN.COM

CHICAGO • DENVER • MINNEAPOLIS • NEW YORK • PHOENIX

Attachment 3: OEM Special Services

Richard A. Renneker WTP (RARWTP) Special Services

MAN DAYS INCLUDED	SERVICES PROVIDED
10	**Equipment Installation Support:** Two Service Personnel for one week (5 Days). Includes on-site time to oversee and assist with the installation of the Wigen supplied equipment. Including, placement of the individual process skids, controls integration, and module installation.
30	**Equipment Start-up & Commissioning:** Two Service Personnel for three weeks (15 Days). Includes preparing the equipment to operate (rinse, backwash, steam, regenerate, etc.), testing control sequences, fully operating the system to achieve performance objectives, filling out commissioning data sheets.
12	**Performance Testing:** Includes site time for the 4 day (2 skids at once) performance testing period per the specification. During the performance test Wigen will have a service tech on-site and monitor the system remotely as needed.
5	**Operator Training:** Includes training on Wigen supplied equipment.
14	**Service Agreement & Remote Monitoring:** Per the specification, Wigen will provide an ongoing service contract comprised of 2 trips for 4 days each and 2 CIP trips for 3 days each.

If additional days are required because site/contractor is unprepared or there are unforeseen customer delays, these additional days will be billed at $1500 per day plus per diem, lodging and travel expenses.

Franklin Area Water Treatment Plant (FAWTP) Special Services

MAN DAYS INCLUDED	SERVICES PROVIDED
10	**Equipment Installation Support:** Two Service Personnel for one week (5 Days). Includes on-site time to oversee and assist with the installation of the Wigen supplied equipment. Including, placement of the individual process skids, controls integration, and module installation.
30	**Equipment Start-up & Commissioning:** Two Service Personnel for three weeks (15 Days). Includes preparing the equipment to operate (rinse, backwash, steam, regenerate, etc.), testing control sequences, fully operating the system to achieve performance objectives, filling out commissioning data sheets.
8	**Performance Testing:** Includes site time for the 4 day (2 skids at once) performance testing period per the specification. During the performance test Wigen will have a service tech on-site and monitor the system remotely as needed.
5	**Operator Training:** Includes training on Wigen supplied equipment.
14	**Service Agreement & Remote Monitoring:** Per the specification, Wigen will provide an ongoing service contract comprised of 2 trips for 4 days each and 2 CIP trips for 3 days each.

If additional days are required because site/contractor is unprepared or there are unforeseen customer delays, these additional days will be billed at $1500 per day plus per diem, lodging and travel expenses.

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Attachment 4: **OEM Warranty**

Limited Mechanical Equipment **Warranty**

Wigen Companies, Inc., d/b/a Wigen Water Technologies, referred to hereinafter as "WWT," warrants that for a period of 18 months from the date of shipment or 12 months from System Acceptance [whichever occurs sooner] any equipment or other product it manufactures: (1) Will be free of defects in material and workmanship, and, (2) if WWT has recommended or manufactured a specific product based on written plans and specifications or a written statement of requirements provided by Buyer, that the product will be fit for the purpose identified in such written plans, specifications, or statement of requirements; provided, however, that such warranties shall be void if the product is not installed, operated or used in accordance with WWT's written instructions (including, without limitation, installation and operating instructions and manuals). **THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED AND WWT EXPRESSLY DISCLAIMS ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** The foregoing warranties apply only to the original purchaser, and do not extend to any subsequent owner.

WWT'S LIABILITY UPON THE FOREGOING WARRANTIES SHALL BE LIMITED TO, AT WWT'S OPTION, REPAIRING OR REPLACING THE DEFECTIVE EQUIPMENT OR COMPONENTS THEREOF WITHOUT CHARGE, F.O.B. WWT'S FACTORY. Buyer shall provide WWT with reasonable opportunities to make inspections, tests, and repairs using the most cost effective methods available. Without limiting the foregoing, WWT disclaims any and all liability for penalties, special or punitive damages, damages for loss of profits or business, lost revenues, loss of use of the product or any associated equipment, cost of capital, facilities or services, down-time, shut-down or slow-down costs, or any other economic losses or property damage. Buyer shall indemnify WWT against any and all losses, liabilities, damages and expenses (including attorneys' fees or any costs required to defend any legal action) based on defects that are proven not to be the fault or negligence of WWT. WWT will not be liable for damage or wear to products or materials due to or caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, if the product was not installed or applied in accordance with WWT's installation or operating instructions, or, if WWT recommended or manufactured a specific product based on plans and specifications or stated requirements provided by Buyer, if Buyer deviates from the plans and specifications or stated requirements that were provided to WWT. No allowance will be made for repairs or alterations made without WWT's written consent or approval, and any such repairs made without WWT's written consent or approval will render the warranties null and void. No equipment shall be returned to WWT without first obtaining WWT's prior written authorization. If it is determined that WWT is not responsible under the terms of this agreement for any such inspections, tests, repairs or replacements, the Buyer shall pay WWT for such inspections, tests, repairs and replacements at WWT's prevailing rates in effect from time to time.

MEMBRANES AND MEDIA PRODUCTS ARE COVERED BY WWT, BUT ONLY TO THE EXTENT THAT COVERAGE IS OFFERED BY THE ORIGINAL EQUIPMENT MANUFACTURER (OEM) OF SUCH PRODUCTS, AND WWT DOES NOT PROVIDE ANY WARRANTIES OR REMEDIES BEYOND THAT WHICH IS EXPRESSLY STATED IN THE OEM'S OWN WARRANTY DOCUMENTS.

To obtain warranty service for WWT products, the defective product must be returned to WWT together with proof of purchase, installation date, failure date, and supporting technical data. Any defective product returned to the factory must be sent freight prepaid. Documentation supporting the warranty claim and a Returned Material Authorization (RMA) number must be included. Contact your WWT salesperson for details on obtaining a RMA number.

SERVICES: Any services WWT hereafter provides with respect to products purchased from WWT or others, whether directly or through subcontractors, shall be performed in accordance with the standard of care with which such services are normally provided in the industry. If the services fail to meet the applicable industry standard, and WWT receives notice of such failure within 365 days from the date of completion, WWT will re-perform such services at no cost to Buyer. **RE-PERFORMANCE OF SERVICES SHALL BE BUYER'S SOLE AND EXCLUSIVE REMEDY, AND IN NO EVENT WILL WWT BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL OR OTHER DAMAGES (EVEN IF WWT HAS BEEN MADE AWARE OF THE POSSIBILITY OF SUCH DAMAGES), NOR, IN ANY EVENT, SHALL WWT'S WARRANTY OBLIGATIONS WITH RESPECT TO SERVICES EXCEED 100% OF THE TOTAL COST OF THE SERVICES PROVIDED.**

WARRANTY PERIODS: EVERY CLAIM BY BUYER ALLEGING A DEFECT IN ANY GOODS AND/OR SERVICES PROVIDED SHALL BE DEEMED WAIVED UNLESS SUCH CLAIM IS MADE IN WRITING WITHIN THE APPLICABLE WARRANTY PERIOD AS SET FORTH ABOVE. Provided, however, if a defect in any product manufactured by WWT is latent and not discoverable within the warranty period applicable thereto, any claim arising on account of such latent defect shall be deemed waived unless it is made in writing within a reasonable time, not exceeding 30 days, after such latent defect is or should have been discovered by Buyer.

Limitations / Exclusions: The warranties herein shall not apply to, and WWT shall not be responsible for, any damage to the goods or failure of the services supplied hereunder, to the extent caused by Buyer's neglect, failure to follow operational and maintenance procedures, or the use of technicians not specifically authorized by WWT to maintain or service its equipment. Before receiving the final drawings, programming and intangible property provided by WWT, the Owner shall agree in writing, to hold WWT harmless for subpar performance and/or damage to the equipment, related to changes made without the express written consent of WWT. **THE WARRANTIES AND REMEDIES CONTAINED HEREIN ARE IN LIEU OF AND EXCLUDE ALL OTHER WARRANTIES AND REMEDIES, WHETHER EXPRESSED OR IMPLIED BY OPERATION OF LAW OR OTHERWISE, INCLUDING ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A SPECIFIC PURPOSE.**

System Warranty

Warren County, OH – RARWTP – REV 5/14/20

FilmTec™ **Reverse Osmosis / Nanofiltration Element(s)**
Three-Year Limited SYSTEM Warranty

LIMITED WARRANTIES

DuPont provides limited warranties covering the materials, workmanship and performance of its spiral-wound FilmTec™ reverse osmosis / nanofiltration elements[1,2] ("Element(s)"), when installed, operated and maintained by Customer in accordance with the terms and conditions set forth in this Warranty document and in accordance with DuPont published documentation*. The warranties herein set forth are granted to the Customer by the legal entity of the DuPont group of companies that is selling the Elements to the Customer ("Supplier") and the Customer sole remedy under these warranties shall be against the Supplier. By accepting this Warranty document, the Customer agrees to the terms and conditions set forth herein.

1. Elements used in food or dairy applications, residential, specialty applications and sulfate removal are not covered by this warranty.
2. Nanofiltration elements shall be tested on magnesium sulfate when determining salt passage.

Limited Materials and Workmanship Warranty **("Workmanship Warranty")**

Supplier warrants that the Element(s) are free from defects in materials and workmanship which might prevent the Element(s) to be installed, operated and maintained in accordance with DuPont's published literature. This Workmanship Warranty shall be effective during the period beginning on the date of delivery of any such Element(s) to carrier at shipping point (manufacturing site) and ending twelve (12) months after the date of such delivery. This Workmanship Warranty shall be deemed void if Customer does not install, operate and maintain the Element(s) in accordance with the requirements set forth in this Warranty and in DuPont's published documentation or fails to inform the Supplier of the defect within thirty (30) days from the date on which the defect is noticed or could have been noticed by Customer. Customer's exclusive remedy, and Supplier's sole obligation and exclusive liability, under this Workmanship Warranty is expressly limited to the repair or, at Supplier's discretion, replacement of any Element(s), which is determined by Supplier (as applicable) in its sole discretion, after examination, to be defective under this provision.

* DuPont published documentation mentioned in this System Warranty includes but is not limited to the most recent releases of the following:

- FilmTec™ Reverse Osmosis Membranes Technical Manual (Form No. 45-D01504-en)
- Storage and Shipping of New FilmTec™ Elements (Form No. 45-D01633-en)
- Start-Up Sequence (Form No. 45-D01609-en)
- Biological Fouling Prevention (Form No. 45-D01567-en)
- Cleaning Guidelines (Form No. 45-D01696-en)
- Scaling Prevention - Barium Sulfate Scale Prevention (Form No. 45-D01554-en), Calcium Sulfate Scale Prevention (Form No. 45-D01553-en), Strontium Sulfate Scale Prevention (Form No. 45-D01555-en)
- Shimming Elements (Form No. 45-D01057-en)
- FilmTec™ Elements Operating Limits (Form No. 45-D00691)
- Product Specifications (See Attachment A)
- DuPont published documentation is available at www.dupont.com/water

Limited Initial Performance Warranty ("Initial Performance Warranty")

Supplier warrants that, after stabilization, the Element(s) will meet the initial minimum permeate flow and salt rejection under standard test conditions set forth in the specifications in Attachment A, until the first to occur of:

a. the first thirty (30) days after the first day of Customer's initial installation and use of any such Element(s) in Customer's system; or
b. six (6) months after date of delivery of any such wet Element(s) to carrier at shipping point (manufacturing site); or
c. twelve (12) months after date of delivery of any such dry Element(s) to carrier at shipping point (manufacturing site).

This Initial Performance Warranty shall be deemed void if Customer does not notify Supplier in writing of the Element(s) failure within 30 days after the first day of operation.

Customer's exclusive remedy, and Supplier's sole obligation and exclusive liability, under this Initial Performance Warranty is expressly limited to the repair or, at Supplier's discretion, replacement of any Element(s) that Supplier determines to be in breach of this Initial Performance Warranty upon Supplier's inspection. Failure or refusal to disclose to Supplier the use and operating parameters of Elements in the event of alleged failure of performance shall render this Initial Performance Warranty null and void.

Limited System Performance Warranty ("System Performance Warranty")

Supplier warrants that the Element(s) will have the performance specified in Attachment C (System Performance Criteria). Design Systems Operating Conditions are provided in Attachment D for information purposes only.

This system performance warranty is given for a period of THREE (3) years from the first to occur of

a. Customer's initial installation and use of any Elements in Customer's system
b. Six (6) months after date of delivery of any such wet Element(s) to carrier at shipping point (manufacturing site); or
c. Twelve (12) months after date of delivery of any such dry Element(s) to carrier at shipping point (manufacturing site).

If Supplier determines that Customer's claims under this System Performance Warranty are valid, Customer's exclusive remedy, and Supplier's sole obligation and exclusive liability under this System Performance Warranty is expressly limited to, at Supplier's discretion, the repair of the affected Elements, the refund of the purchase paid by Customer for the affected Element(s), or the replacement of the affected Element(s). Notwithstanding, Supplier has no obligation to repair, refund or replace Element(s) that are at or below the quantity of Element(s) to be repaired, refunded or replaced by Customer per the Replacement Rates set forth as follows:

	Replacement Rate (%)
Period	**FilmTec™ NF90-400/34i**
Year 1	0%
Year 2	27%
Year 3	27%
CARR* after 3 years	18%

* Cumulative Average Replacement Rate.

To the extent that repair, refund or replacement of Elements in the system is not required in any given calendar year then that quantity set forth above shall be carried forward on a cumulative basis and added to the following calendar year replacement rate. During the performance warranty, Supplier will replace or repair Element(s), at Supplier's discretion, in excess of the foregoing cumulative annual replacement rate at Supplier expense. This repair, refund or replacement performance warranty shall be deemed void if Customer does not install, operate and maintain Element(s) in accordance with DuPont's published specifications, the Conditions set forth below, and good engineering practices.

Conditions Voiding the Initial Performance and the System Performance Warranty

The THREE (3) year limited system performance warranty and the limited initial performance warranty described above shall be null and void if any of the following conditions are not met:

a. Customer does not record and maintain, according to Supplier's instructions, operational data according to Attachment B
b. Customer fails to provide Supplier with operational data upon request
c. Customer does not install, operate and maintain the Element(s) in accordance with the requirement set forth in this Warranty and in DuPont published documentation or in accordance with good engineering practices.
d. Customer fails to meet any of the following conditions pertaining to any Element(s) and the system in which any Element(s) is used:
    i. The design parameters (array, recovery, etc.) plus instrumentation and other components of the system in which the Element(s) are employed shall be consistent with sound engineering practice. Customer will allow Supplier to review the system design upon Supplier's request.
    ii. Feedwater temperature must be less than 113°F (45°C) unless otherwise stated in the product data sheet of the element(s) (Attachment A) or in this warranty document. Refer to FilmTec™ Elements Operating Limits (Form No. 45-D00691) for warranty voiding conditions and additional information regarding temperature limits.
    iii. Feedwater SDI (15 min., 30 psi) must be less than 5.0.
    iv. Feedwater must not contain any colloidal sulfur.
    v. Feedwater must not contain any oxidizing agents including, without limitation, chlorine, ozone or permanganate.
    vi. The Element(s) must not be exposed to pressure greater than 1,200 psi for seawater Element(s)s, 600 psi for brackish water Element(s)s and 300 psi for tap water Element(s)s, unless otherwise stated in the product specification or unless otherwise indicated in this warranty document.
    vii. Backpressure (where permeate static pressure exceeds reject static pressure) must not exceed 5 psi at any time.
    viii. Sequestrants (and other chemicals used in the system) must be compatible with the Element(s).
    ix. The Element(s) must not be exposed to a pH of less than 2.0 or more than 11.0 during continuous operation, or a pH of less than 1.0 or more than 13.0 during cleaning unless otherwise indicated in the product specifications or in this Warranty. If pH adjustment is required, chemicals that are compatible with the Element(s) must be used.
    x. The Element(s) must be operationally protected against excessive hydraulic changes including, without limitation, water hammer, and rapid pressure swings.
    xi. The Element(s) must be maintained in a clean condition and must not be contaminated by particulate matter, colloidal or precipitated solids, or biological growth; if scaling or fouling should occur, or normalized Element(s) flow decline of 10 percent, cleaning procedures must be employed in accordance with the procedures published in a literature piece entitled Cleaning Guidelines (Form No. 45-D01696-en).

xii. The system design, operating and maintenance procedures must contain adequate provisions to ensure against contamination by particulate matter, colloidal or precipitated solids, or biological growth.
xiii. There must not be scaling caused by failure of the chemical dosing system or ineffective scale- control practices. (e.g., Ca, Ba, or Sr salts).
xiv. The brine-soluble silica must be less than 150 mg/l at 25°C.
xv. There must not be damage caused by chemical compounds (e.g. surfactants, solvents, soluble oils, free oils, lipids, and high molecular weight natural polymers).
xvi. Element(s) must only be cleaned with compatible chemicals and must not be cleaned with nonionic or cationic surfactants, or any other chemical that is not compatible with the Element(s).
xvii. Customer is responsible for providing the user with adequate system operating and maintenance manuals, operator and supervisor training; and ensuring user's ability to properly perform cleaning and other performance restoration and diagnostic procedures.
xviii. Customer is responsible for ensuring that frequent, adequate system and subsystem performance data are normalized and routinely recorded in a systematic format regularly reviewed. Customer will make this data available to Supplier on a reasonable basis in the event a claim is made against Supplier pursuant to the Initial Performance Warranty or the 3Yr Performance Warranty.
xix. Element(s) must be stored in accordance with DuPont's published documentation and specifications.
xx. Permeate and concentrate obtained from the first hour of operation must be discharged.
xxi. Field preservation and cleaning of Element(s) must be done in accordance with DuPont's published documentation.
xxii. Element(s) must be stored in accordance with DuPont's published guidelines.
xxiii. Customer must keep Element(s) moist at all times after initial wetting.
xxiv. Supplier will have the final decision on Element(s) replacement or repair necessary to maintain output quality and quantity.
xxv. Customer's failure or refusal to disclose to Supplier the use and operating parameters of Elements in the event of failure of performance.
xxvi. Failure of the customer to notify Supplier in writing of the Element(s) failure within 30 days after first non-compliance with performance standards set forth herein.

Conditions voiding all Warranties

In addition, all the foregoing warranties (i.e. the Workmanship Warranty, the Initial Performance Warrant and the System Performance Warranty) do not cover and shall be null and void if any of the following conditions are not met:

a. If Customer is not current on all payments due to Supplier, then this warranty is null and void.
b. Accidental and/or external caused damages and damages caused by improper use are excluded from these warranties. Accidental and/or external caused damages and damages caused by improper use are damages caused by but not limited to operation and/or exposure of Element(s) to conditions, outside the instructions and conditions listed in FilmTec™ Elements' product datasheets and specifications and in this Warranty document. If there is any dispute with respect to the above, the Customer should provide evidence to Supplier.
c. Expendable parts and components (e.g. o-rings) are specifically outside of these warranties

d. Damage or malfunction arising from repairs, replacement(s) or substitution(s) not specifically authorized by Supplier are specifically outside of these warranties.
e. Any defects or faults caused by, or resulting from, inaccurate or incomplete operating process information / process operating parameters, or work performed by the Customer or its authorized representative, are specifically excluded from these warranties.
f. If Customer does not furnish adequate and competent operating, supervisory and maintenance staff, and necessary laboratory facilities with test equipment and personnel, then these warranties are null and void.
g. Supplier understands that the Element(s) will be used as a part of a larger water or wastewater treatment process. Supplier must be given the opportunity, with a reasonable notice, to review engineering documents and attend testing and commissioning activities of all aspects of the water or wastewater treatment process which may affect membrane lifetime and performance, or these warranties are null and void. Neither a review of the engineering documents nor attendance of testing or commissioning nor the declining of the opportunity enlarges Supplier's warranties hereunder nor creates any liability or constitutes any endorsement by Supplier for any aspect of the system.
h. In the case where the Customer and user are separate parties, the Customer has sole and exclusive responsibility for making the user aware of its responsibility under the conditions of these warranties. Failure of the Customer to meet its respective obligations set forth in this Warranty document may invalidate these Warranties.

No other warranties & Limitation of Liability

A. The limited warranties granted herein are the sole warranties provided by Supplier with respect to the Elements (including without limitation with respect to Elements quality and performance) and all other warranties, whether express, statutory or implied, including without limitation any implied warranties of fitness for a particular purpose or merchantability are excluded and disclaimed. Supplier's warranties as hereinabove set forth shall not be enlarged, diminished or otherwise affected by, nor shall any obligation or liability of Supplier arise out of, Supplier's or its affiliates' rendering of technical advice or service in connection with the Elements supplied.

B. SUPPLIER'S LIABILITY FOR ANY BREACH OF THESE WARRANTIES SHALL BE LIMITED TO THE REMEDIES EXPRESSLY SET FORTH HEREIN. IN NO EVENT SHALL SUPPLIER BE LIABLE FOR ANY DAMAGE, COSTS OR EXPENSES ASSOCIATED WITH WARRANTY, WHETHER FOR THE REPLACEMENT OR REPAIR OF ELEMENTS, INCLUDING LABOR, INSTALLATION OR OTHER COSTS INCURRED BY CUSTOMER AND, IN PARTICULAR, ANY COSTS RELATED TO THE REMOVAL OR REPLACEMENT OF ANY ELEMENTS INCORPORATED INTO A SYSTEM OR OTHERWISE. WITHOUT PREJUDICE TO SUPPLIER'S OBLIGATIONS UNDER THESE WARRANTIES, CUSTOMER ASSUMES ALL RISKS AND LIABILITIES RESULTING FROM THE USE OF THE ELEMENTS. SUPPLIER'S LIABILITY FOR CONSEQUENTIAL, PUNITIVE, SPECIAL, EXEMPLARY OR INCIDENTAL DAMAGES OR FOR LOSS OF PRODUCTION, LOSS OF PROFITS OR REVENUES ARISING OUT OF OR IN CONNECTION WITH THE USE OF THE ELEMENTS OR A BREACH OF THESE WARRANTIES IS EXCLUDED.

C. Prior to issuing any refund or credit or shipping any replacement of Element(s), Supplier reserves the right to test the alleged defective Element(s) and systems on user's or Customer's premises, or to request Customer to perform such inspections or tests and forward the results thereof to Supplier.

D. If Element(s) failure is determined by Supplier to be from any cause other than breach of the warranties herein set above, Customer shall pay to Supplier a fee of US$1,000.00 per day, plus direct travel expenses incurred by Supplier's employees, in connection with any inspection and testing of such Element(s) and system on user's or Customer's premises.
E. Elements shipped to Supplier for warranty examination must be shipped freight prepaid. Elements examined as part of a warranty claim which are found to be performing as warranted will be returned to the Customer freight collect.
F. Failure or refusal by Customer to fully disclose to Supplier the use and operating parameters for the Element(s) as set forth in Attachment B, Mandatory Measurement and Recording of Operating Parameters, shall render all warranties other than that covering materials and workmanship null and void.
G. Warranty of replacement Element(s) will be limited to the duration of these limited warranties.

Warranty Claim and Notice Procedures

Before returning any Element(s) to Supplier for warranty examination, Supplier must be contacted to obtain a service request number. Any Element(s) shipped to Supplier's facility without proper return documentation will be returned to shipper unopened, freight collected.

The following procedure shall be followed to determine warranty protection:

1. Customer shall send a written notice to Supplier within thirty (30) days of problem occurrence or such other time period as otherwise specified herein or the claim will be deemed waived.
2. Customer shall submit all relevant operating data requested by the Supplier.
3. Supplier will be provided a reasonable time to review the data and make initial recommendations in writing for further evaluation of the claim.
4. Customer will make all reasonable efforts to execute and implement the Supplier's recommendations and collect, record and submit all relevant data resulting from these recommendations.
5. In the event Supplier's initial recommendations do not address and solve the performance issues, the Customer will grant Supplier access to the system and a reasonable time to perform testing and evaluation of Element(s) conditions and performance.
6. In the event Supplier's recommendations address and solve the performance issues, the claim shall immediately be withdrawn and dismissed.
7. In the case the Customer decides not to follow Supplier's recommendations then the claim will be deemed withdrawn and dismissed.

Any defective Element(s) shall be returned to the Supplier at the Customer's expense if so requested by the Supplier in accordance to Supplier's return procedures.

Important Reminders

A. Formaldehyde is not recommended as preservation liquid and is not supported as a preservative for drinking water applications. The Element(s) must be in use for at least 24 hours of continuous operation before formaldehyde is used as a biocide. If such Element(s) are exposed to formaldehyde before this period, a severe loss in flux may result.
B. The use of Element(s) in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.

Attachments

Attachment A, Element(s) Specifications
Attachment B, Mandatory Measurement and Recording of Operating Parameters
Attachment C, System Performance Criteria
Attachment D, Design Operating Conditions

Contact DuPont Water Solutions:
www.dupont.com/water/contact-us

Governing Law
This limited warranty agreement shall be governed by and construed in accordance with the laws of the State of Delaware where the DuPont selling legal entity is established in the U.S.A. or the laws of the country where the DuPont selling legal entity is established in all other cases. The conflict of laws provisions of the applicable law as per the foregoing and the United Nations Convention on Contracts for the International Sale of Goods shall not apply.

Non-assignment
The rights and duties under this limited warranty agreement are not assignable or transferable by either party without the other's written consent, except that Customer hereby consents to Supplier's potential future assignment of some or all of Supplier's obligations hereunder to any affiliate of Supplier without further notice to Customer.

READ, UNDERSTOOD AND AGREED

FilmTec Corporation	Customer
By: _____	By: _____
Name: _____	Name: _____
Title: _____	Title: _____
Date: _____	Date: _____

Attachment A

FilmTec™ Membranes

DuPont's Published Data Sheet Specifications

Product Data Sheet

FilmTec™ NF90-400/34i Element

Description

Ideal for: utility managers and operators looking for a technology that delivers high quality permeate water while removing specific contaminants such as salts, nitrates, iron, and organic compounds.

The FilmTec™ NF90-400/34i Element:

- Delivers high productivity and cleanability due to its high active area and widest cleaning pH range (1-13) tolerance
- Offers a nanofiltration technology that selectively removes these components, color and operates at low operating pressures
- Including iLEC™ interlocking end caps, reducing system operating costs and the risk of o-ring leaks that can cause poor water quality

Product Type

Spiral-wound element with polyamide thin-film composite membrane

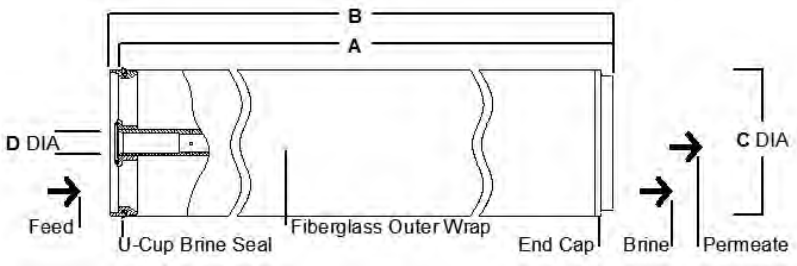
Typical Properties

	Active Area			Permeate Flow Rate		
FilmTec™ Element	(ft^2)	(m^2)	Feed Spacer Thickness (mil)	(GPD)	(m^3/d)	Minimum Salt Rejection (%)
NF90-400/34i	400	37	34-LDP	10,000	38	98.7%

1. Permeate flow and salt passage based on the following test conditions:2,000 mg/l $MgSO_4$, 70 psi (4.8 bar), 77°F (25°C) and 15% recovery.
2. Flow rates for individual elements may vary but will be no more than +15%.
3. Stabilized salt rejection is generally achieved within 24-48 hours of continuous use; depending upon feedwater characteristics and operating conditions.
4. Sales specifications may vary as design revisions take place.
5. Active area guaranteed ±3%. Active area as stated by DuPont Water Solutions is not comparable to nominal membrane area often stated by some manufacturers.

Form No. 45-D01698-en, Rev. 4
January 2020

Element Dimensions



Dimensions – inches (mm)								1 inch = 25.4 mm
	A		B		C		D	
FilmTec™ Element	(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(in.)	(mm)
NF90-400/34i	40.0	1,016	40.5	1,029	7.9	201	1.125 ID	29 ID

1. Refer to FilmTec™ Design Guidelines for multiple-element systems of 8-inch elements (Form No. 45-D01695-en).
2. Element to fit nominal 8-inch (203-mm) I.D. pressure vessel.
3. Individual elements with iLEC™ endcaps measure 40.5 inches (1,029 mm) in length (B). The net length (A) of the elements when connected is 40.0 inches (1,016 mm).

Operating and Cleaning Limits

Maximum Operating Temperature [a]	113°F (45°C)
Maximum Operating Pressure	600 psig (41 bar)
Maximum Element Pressure Drop	15 psig (1.0 bar)
pH Range	
Continuous Operation [a]	2 – 11
Short-Term Cleaning (30 min.) [b]	1 – 13
Maximum Feed Silt Density Index (SDI)	SDI 5
Free Chlorine Tolerance [c]	< 0.1 ppm

a. Maximum temperature for continuous operation above pH 10 is 95°F (35°C).
b. Refer to Cleaning Guidelines (Form No. 45-D01696-en).
c. Under certain conditions, the presence of free chlorine and other oxidizing agents will cause premature membrane failure. Since oxidation damage is not covered under warranty, DuPont Water Solutions recommends removing residual free chlorine by pretreatment prior to membrane exposure. Please refer to Dechlorinating Feedwater (Form No. 45-D01569-en) for more information.

Additional Important Information

Before use or storage, review these additional resources for important information:

- Usage Guidelines for FilmTec™ 8" Elements (Form No. 45-D01706-en)
- Start-Up Sequence (Form No. 45-D01609-en)

Product Stewardship

DuPont has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with DuPont products—from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Form No. 45-D01698-en, Rev. 4
January 2020

Customer Notice

DuPont strongly encourages its customers to review both their manufacturing processes and their applications of DuPont products from the standpoint of human health and environmental quality to ensure that DuPont products are not used in ways for which they are not intended or tested. DuPont personnel are available to answer your questions and to provide reasonable technical support. DuPont product literature, including safety data sheets, should be consulted prior to use of DuPont products. Current safety data sheets are available from DuPont.

Please be aware of the following:

- The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.
- Permeate obtained from the first hour of operation should be discarded.

Regulatory Note

This product may be subject to drinking water application restrictions in some countries; please check the application status before use and sale.

Have a question? Contact us at:

www.dupont.com/water/contact-us

Form No. 45-D01698-en, Rev. 4
January 2020

Attachment B

FilmTec™ Membranes

Mandatory Measurement and Recording of Operating Parameters

From the effective date of the Initial Performance Warranty and the system warranty the following items shall be accurately recorded by continuous on-line recording equipment, and/or by manual measurement and recording at least once per operator shift, for each train:

a. Continuous on-line recording
   i. Raw and acidified feedwater pH value
   ii. Conductivity of feedwater and permeate
   iii. Feedwater residual chlorine concentration.
   iv. Feedwater pressure.
   v. Combined total permeate flow rate and conductivity.
   vi. Acid dosing rate (if used).
   vii. Antiscalant dosing rate.
   viii. Feedwater temperature.
   ix. Permeate Pressure
   x. Differential pressure between feed and concentrate (Δp)

If the system consists of more than one stage or more than one pass, in addition to the parameters listed above, the following parameters will be required as well for each individual stage of every pass:

   xi. Feed Pressure, Permeate pressure and Δp.
   xii. Feed and permeate conductivity
   xiii. Feed and permeate flow

b. Manual measurement / lab testing and recording at least one (1) time per day
   i. All items of continuous recording listed above.
   ii. Feed water Silt Density Index, SDI (15min, 30psi).
   iii. Recovery rate.
   iv. Train flow balance (total feed, concentrate and permeate).
   v. Train mass balance (total feed, concentrate and permeate).
   vi. Train chloride ion balance (total feed, concentrate and permeate).

c. Laboratory measurement and recording at least once per month
   i. Total dissolved solids of feedwater, brine and permeate
   ii. Complete feedwater analysis for the constituents listed in the water analysis.

d. Calibration check of all sensors of continuous recording shall be done at least once per month
   Customer shall document and maintain the data in a systematic and presentable format, and shall make the data available to Supplier at Supplier's request.

Attachment C

FilmTec™ Membranes

SYSTEM PERFORMANCE CRITERIA

Warren County, OH – RAR WTP 5.175 MGD Total Permeate Capacity		
Feed Flow (1 train)	gpm	1,288
Permeate Flow (1 train)	gpm	1,030
Concentrate Flow (1 train)	gpm	258
Train Recovery	%	80
Feed TDS	mg/L	< 640
Feed Cl	mg/L	< 65
Feed Total Hardness	mg/l as $CaCO_3$	< 270
Feed temperature	ºF	55 - 60
SDI	% / min	< 3 (100% of the time)
Element type		NF90-400/34i
Element area	ft^2	400
Number of NF Trains	-	6
Number of Stage 1 Pressure Vessels		24
Number of Stage 2 Pressure Vessels	-	12
Number of Elements per Vessel	-	7
Number of Elements - Total	-	1,512
Average Permeate Flux	gfd	14.7
		Warranted Values
Feed Pressure Warranted	psig	≤ 140
Total Permeate $TDS_{180°C}$ Warranted	mg/L	< 30
Total Permeate Hardness Warranted	mg/l as $CaCO_3$	< 15
Total Permeate Cl warranted	mg/L	< 10
CARR% (3 years)	%	18

(*) $TDS_{180°C}$ = sum of K, Na, Ca, Mg, 50% of HCO3, Cl, SO_4, SiO_2

Attachment D

FilmTec™ Membranes

Design Operating Conditions

(Insert here a copy of RO/NF System Calculations once agreed with the Customer)

WATER APPLICATION VALUE ENGINE

WATER SOLUTIONS

WAVE Program Version: 1.75.754

Calculation Engine Version: 01.11.12.00

Database Version: 17.0

RO

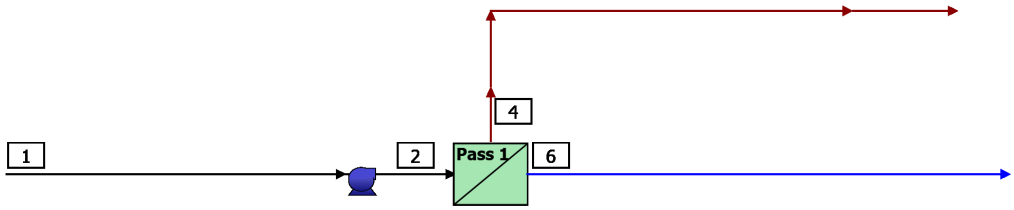
Project Name:	RARWTP
Case Name:	Start-up - 60 deg F
Customer:	
Prepared by:	Steven Coker
Company:	DuPont
Country:	
Date Created:	May 12, 2020
Project Notes:	
Case #:	1 of: 5
Case Notes:	Case 1
Keywords:	

Additional Feed Water Information

Stream 1: Added sulfate to balance feed water

RO Detailed Report

RO System Flow Diagram



#	Description	Flow (gpm)	TDS (mg/L)	Pressure (psi)
1	Raw Feed to RO System	1,288	636.3	0.0
2	Net Feed to Pass 1	1,287	636.5	108.4
4	Total Concentrate from Pass 1	257.8	3,075	75.6
6	Net Product from RO System	1,030	24.09	15.0

RO System Overview

Total # of Trains	1	Online =	1	Standby =	0	RO Recovery	80.0 %
System Flow Rate	(gpm)	Net Feed =	1,288	Net Product =	1,030		

Pass		Pass 1
Stream Name		Stream 1
Water Type		Well Water (SDI < 3)
Number of Elements		252
Total Active Area	(ft^2)	100800
Feed Flow per Pass	(gpm)	1,287
Feed TDS[a]	(mg/L)	636.5
Feed Pressure	(psi)	108.4
Flow Factor		0.95
Permeate Flow per Pass	(gpm)	1,030
Pass Average flux	(gfd)	14.7
Permeate TDS[a]	(mg/L)	24.09
Pass Recovery		80.0 %
Average NDP	(psi)	53.5
Specific Energy	(kWh/kgal)	1.23
Temperature	(°F)	60.0
pH		7.1
Chemical Dose		
RO System Recovery		80.0 %
Net RO System Recovery		80.0%

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Flow Table (Stage Level) - Pass 1

Stage	Elements	#PV	#Els per PV	Feed				Concentrate			Permeate			
				Feed Flow	Recirc Flow	Feed Press	Boost Press	Conc Flow	Conc Press	Press Drop	Perm Flow	Avg Flux	Perm Press	Perm TDS
			PV	(gpm)	(gpm)	(psi)	(psi)	(gpm)	(psi)	(psi)	(gpm)	(gfd)	(psi)	(mg/L)
1	NF90-400/34i	24	7	1,287	0.00	105.4	0.0	580.5	91.0	14.4	707.1	15.2	35.0	16.88
2	NF90-400/34i	12	7	580.5	0.0	88.0	0.0	257.8	75.6	12.4	322.8	13.8	15.0	39.94

RO Solute Concentrations - Pass 1

Concentrations (mg/L as ion)						
	Feed	Concentrate		Permeate		
		Stage1	Stage2	Stage1	Stage2	Total
NH_4^+	0.00	0.00	0.00	0.00	0.00	0.00
K^+	2.90	6.20	13.40	0.19	0.45	0.27
Na^+	33.00	70.83	153.7	1.96	4.60	2.79
Mg^{+2}	27.00	59.22	131.7	0.56	1.34	0.81
Ca^{+2}	102.0	223.8	497.7	2.06	4.94	2.96
Sr^{+2}	0.33	0.72	1.61	0.01	0.02	0.01
Ba^{+2}	0.10	0.22	0.49	0.00	0.00	0.00
CO_3^{-2}	0.31	1.68	9.01	0.00	0.00	0.00
HCO_3^-	310.3	677.2	1,492	7.67	18.11	10.92
NO_3^-	0.56	1.10	2.18	0.11	0.24	0.15
Cl^-	63.00	135.8	296.3	3.23	7.62	4.60
F^-	2.00	4.27	9.20	0.14	0.33	0.20
SO_4^{-2}	88.55	195.5	438.0	0.75	1.82	1.09
SiO_2	6.30	13.74	30.37	0.19	0.46	0.28
Boron	0.00	0.00	0.00	0.00	0.00	0.00
CO_2	35.01	35.60	38.62	35.03	36.25	35.43
TDS[a]	636.3	1,390	3,075	16.88	39.94	24.09
pH	7.1	7.4	7.7	5.6	6.0	5.8

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Design Warnings

None

RO Flow Table (Element Level) - Pass 1

Stage	Element	Element Name	Recovery (%)	Feed Flow (gpm)	Feed Press (psi)	Feed TDS (mg/L)	Conc Flow (gpm)	Perm Flow (gpm)	Perm Flux (gfd)	Perm TDS (mg/L)
1	1	NF90-400/34i	9.0	53.6	105.4	636.5	48.8	4.82	17.4	10.64
1	2	NF90-400/34i	9.4	48.8	102.4	698.3	44.3	4.57	16.5	12.23
1	3	NF90-400/34i	9.8	44.3	99.7	769.2	39.9	4.35	15.7	14.11
1	4	NF90-400/34i	10.4	39.9	97.4	851.5	35.7	4.16	15.0	16.34
1	5	NF90-400/34i	11.2	35.7	95.4	948.7	31.7	4.00	14.4	19.04
1	6	NF90-400/34i	12.1	31.7	93.7	1,066	27.9	3.85	13.9	22.38
1	7	NF90-400/34i	13.3	27.9	92.2	1,209	24.2	3.71	13.4	26.63
2	1	NF90-400/34i	9.5	48.4	88.0	1,390	43.8	4.58	16.5	23.97
2	2	NF90-400/34i	9.8	43.8	85.4	1,533	39.5	4.31	15.5	27.98
2	3	NF90-400/34i	10.3	39.5	83.1	1,697	35.4	4.06	14.6	32.82
2	4	NF90-400/34i	10.8	35.4	81.1	1,887	31.6	3.82	13.8	38.71
2	5	NF90-400/34i	11.4	31.6	79.4	2,110	28.0	3.60	13.0	46.00
2	6	NF90-400/34i	12.1	28.0	77.9	2,375	24.6	3.38	12.2	55.19
2	7	NF90-400/34i	12.8	24.6	76.7	2,692	21.5	3.15	11.3	67.03

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Solubility Warnings

Warning	Pass No
Langelier Saturation Index > 0	1
$BaSO_4$ (% saturation) > 100	1
CaF_2 (% saturation) > 100	1
Anti-scalants may be required. Consult your anti-scalant manufacturer for dosing and maximum allowable system recovery.	1

RO Chemical Adjustments

	Pass 1 Feed	RO 1st Pass Conc
pH	7.1	7.7
Langelier Saturation Index	-0.19	1.66
Stiff & Davis Stability Index	0.35	1.62
TDS[a] (mg/l)	636.3	3,075
Ionic Strength (molal)	0.01	0.07
HCO_3^- (mg/L)	310.3	1,492
CO_2 (mg/l)	35.00	38.62
CO_3^{-2} (mg/L)	0.31	9.01
$CaSO_4$ (% saturation)	2.0	25.7
$BaSO_4$ (% saturation)	268.7	2,370
$SrSO_4$ (% saturation)	0.61	4.0
CaF_2 (% saturation)	57.4	2,337
SiO_2 (% saturation)	5.9	28.6
$Mg(OH)_2$ (% saturation)	0.00	0.00

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Utility and Chemical Costs

Service Water

	Flow Rate (gpm)	Unit Cost ($/kgal)	Hourly Cost ($/h)	Daily Cost ($/d)
Non-Product Feed Water				
Pass 1	257.8	0.5300	0.01	0.14
Total Non-product Feed Water Cost	257.8		0.01	0.14
Waste Water Disposal				
Pass 1	257.8	2.6100	0.04	0.98
Total Waste Water Disposal	257.8		0.04	0.98
Total Service Water Cost				1.12

Electricity

Peak Power	(kW)	76.1
Energy	(kWh/d)	1,826
Electricity Unit Cost	($/kWh)	0.0373
Electricity Cost	($/d)	68.1
Specific Energy	(kWh/kgal)	1.23

Pump	Flow Rate (gpm)	Power (kW)	Energy (kWh/d)	Cost ($/d)
Pass 1				
Feed	1,287.47	76.08	1,825.88	68.13
Pass 1 Total Electrical Cost		76.08	1,825.88	68.13

Chemical

Chemical	Unit Cost ($/kg)	Dose (mg/L)	Volume (L/d)	Cost ($/d)
Total Chemical Cost				0.0

Utility and Chemical Cost	($/d)	69.2
Specific Water Cost	($/kgal)	0.047

WATER APPLICATION VALUE ENGINE

WATER SOLUTIONS

WAVE Program Version: 1.75.754

Calculation Engine Version: 01.11.12.00

Database Version: 17.0

RO

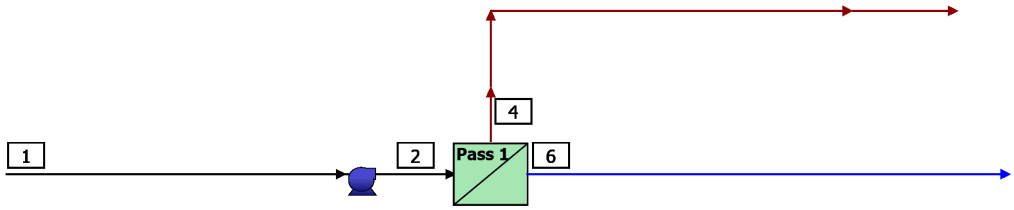
Project Name:	RARWTP
Case Name:	Start-up - 55 deg F
Customer:	
Prepared by:	Steven Coker
Company:	DuPont
Country:	
Date Created:	May 12, 2020
Project Notes:	
Case #:	2 of: 5
Case Notes:	Case 2
Keywords:	

Additional Feed Water Information

Stream 1: Added sulfate to balance water

RO Detailed Report

RO System Flow Diagram



#	Description	Flow (gpm)	TDS (mg/L)	Pressure (psi)
1	Raw Feed to RO System	1,288	636.3	0.0
2	Net Feed to Pass 1	1,287	636.4	127.2
4	Total Concentrate from Pass 1	257.6	3,093	92.8
6	Net Product from RO System	1,030	20.21	15.0

RO System Overview

Total # of Trains	1	Online =	1	Standby =	0	RO Recovery	80.0 %
System Flow Rate	(gpm)	Net Feed =	1,288	Net Product =	1,030		

Pass		Pass 1
Stream Name		Stream 1
Water Type		Well Water (SDI < 3)
Number of Elements		252
Total Active Area	(ft^2)	100800
Feed Flow per Pass	(gpm)	1,287
Feed TDS[a]	(mg/L)	636.4
Feed Pressure	(psi)	127.2
Flow Factor		0.80
Permeate Flow per Pass	(gpm)	1,030
Pass Average flux	(gfd)	14.7
Permeate TDS[a]	(mg/L)	20.21
Pass Recovery		80.0 %
Average NDP	(psi)	71.7
Specific Energy	(kWh/kgal)	1.44
Temperature	(°F)	55.0
pH		7.1
Chemical Dose		
RO System Recovery		80.0 %
Net RO System Recovery		80.0%

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Flow Table (Stage Level) - Pass 1

Stage	Elements	#PV	#Els per PV	Feed				Concentrate			Permeate			
				Feed Flow	Recirc Flow	Feed Press	Boost Press	Conc Flow	Conc Press	Press Drop	Perm Flow	Avg Flux	Perm Press	Perm TDS
			PV	(gpm)	(gpm)	(psi)	(psi)	(gpm)	(psi)	(psi)	(gpm)	(gfd)	(psi)	(mg/L)
1	NF90-400/34i	24	7	1,287	0.00	124.2	0.0	582.8	109.0	15.3	704.7	15.1	35.0	14.19
2	NF90-400/34i	12	7	582.8	0.0	106.0	0.0	257.6	92.8	13.2	325.3	13.9	15.0	33.30

RO Solute Concentrations - Pass 1

Concentrations (mg/L as ion)						
	Feed	Concentrate		Permeate		
		Stage1	Stage2	Stage1	Stage2	Total
NH_4^+	0.00	0.00	0.00	0.00	0.00	0.00
K^+	2.90	6.21	13.58	0.16	0.38	0.23
Na^+	33.00	70.91	155.6	1.65	3.86	2.35
Mg^{+2}	27.00	59.08	132.3	0.47	1.12	0.67
Ca^{+2}	102.0	223.2	499.9	1.72	4.11	2.48
Sr^{+2}	0.33	0.72	1.62	0.01	0.01	0.01
Ba^{+2}	0.10	0.22	0.49	0.00	0.00	0.00
CO_3^{-2}	0.31	1.64	8.92	0.00	0.00	0.00
HCO_3^-	310.3	675.9	1,500	6.46	15.07	9.16
NO_3^-	0.56	1.12	2.26	0.10	0.21	0.13
Cl^-	63.00	135.9	299.4	2.71	6.38	3.87
F^-	2.00	4.28	9.33	0.12	0.27	0.17
SO_4^{-2}	88.55	194.9	439.0	0.63	1.51	0.91
SiO_2	6.30	13.72	30.57	0.16	0.38	0.23
Boron	0.00	0.00	0.00	0.00	0.00	0.00
CO_2	35.00	35.57	38.58	35.01	36.21	35.40
TDS[a]	636.3	1,388	3,093	14.19	33.30	20.21
pH	7.1	7.4	7.7	5.6	5.9	5.7

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Design Warnings

None

RO Flow Table (Element Level) - Pass 1

Stage	Element	Element Name	Recovery (%)	Feed Flow (gpm)	Feed Press (psi)	Feed TDS (mg/L)	Conc Flow (gpm)	Perm Flow (gpm)	Perm Flux (gfd)	Perm TDS (mg/L)
1	1	NF90-400/34i	8.7	53.6	124.2	636.4	49.0	4.66	16.8	9.19
1	2	NF90-400/34i	9.1	49.0	121.1	696.1	44.5	4.47	16.1	10.43
1	3	NF90-400/34i	9.7	44.5	118.3	765.0	40.2	4.31	15.5	11.90
1	4	NF90-400/34i	10.4	40.2	115.8	845.6	36.0	4.16	15.0	13.66
1	5	NF90-400/34i	11.2	36.0	113.7	941.6	32.0	4.03	14.5	15.80
1	6	NF90-400/34i	12.2	32.0	111.8	1,058	28.1	3.92	14.1	18.47
1	7	NF90-400/34i	13.6	28.1	110.3	1,203	24.3	3.81	13.7	21.91
2	1	NF90-400/34i	9.1	48.6	106.0	1,388	44.1	4.44	16.0	20.54
2	2	NF90-400/34i	9.6	44.1	103.2	1,525	39.9	4.23	15.2	23.67
2	3	NF90-400/34i	10.1	39.9	100.8	1,684	35.9	4.04	14.6	27.42
2	4	NF90-400/34i	10.8	35.9	98.6	1,871	32.0	3.86	13.9	31.99
2	5	NF90-400/34i	11.5	32.0	96.8	2,092	28.3	3.69	13.3	37.66
2	6	NF90-400/34i	12.4	28.3	95.3	2,359	24.8	3.51	12.6	44.87
2	7	NF90-400/34i	13.4	24.8	93.9	2,686	21.5	3.33	12.0	54.28

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Solubility Warnings

Warning	Pass No
Langelier Saturation Index > 0	1
$BaSO_4$ (% saturation) > 100	1
CaF_2 (% saturation) > 100	1
Anti-scalants may be required. Consult your anti-scalant manufacturer for dosing and maximum allowable system recovery.	1

RO Chemical Adjustments

	Pass 1 Feed	RO 1st Pass Conc
pH	7.1	7.7
Langelier Saturation Index	-0.23	1.62
Stiff & Davis Stability Index	0.32	1.59
TDS[a] (mg/l)	636.3	3,093
Ionic Strength (molal)	0.01	0.07
HCO_3^- (mg/L)	310.3	1,500
CO_2 (mg/l)	35.00	38.58
CO_3^{-2} (mg/L)	0.31	8.92
$CaSO_4$ (% saturation)	2.0	25.8
$BaSO_4$ (% saturation)	268.7	2,377
$SrSO_4$ (% saturation)	0.61	4.0
CaF_2 (% saturation)	57.4	2,408
SiO_2 (% saturation)	6.3	30.4
$Mg(OH)_2$ (% saturation)	0.00	0.00

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Utility and Chemical Costs

Service Water

	Flow Rate (gpm)	Unit Cost ($/kgal)	Hourly Cost ($/h)	Daily Cost ($/d)
Non-Product Feed Water				
Pass 1	257.6	0.5300	0.01	0.14
Total Non-product Feed Water Cost	257.6		0.01	0.14
Waste Water Disposal				
Pass 1	257.6	2.6100	0.04	0.98
Total Waste Water Disposal	257.6		0.04	0.98
Total Service Water Cost				1.12

Electricity

Peak Power	(kW)	89.3
Energy	(kWh/d)	2,142
Electricity Unit Cost	($/kWh)	0.0373
Electricity Cost	($/d)	80.0
Specific Energy	(kWh/kgal)	1.44

Pump	Flow Rate (gpm)	Power (kW)	Energy (kWh/d)	Cost ($/d)
Pass 1				
Feed	1,287.37	89.27	2,142.47	79.95
Pass 1 Total Electrical Cost		89.27	2,142.47	79.95

Chemical

Chemical	Unit Cost ($/kg)	Dose (mg/L)	Volume (L/d)	Cost ($/d)
Total Chemical Cost				0.0

Utility and Chemical Cost	($/d)	81.1
Specific Water Cost	($/kgal)	0.055

WATER APPLICATION VALUE ENGINE

WATER SOLUTIONS

WAVE Program Version: 1.75.754

Calculation Engine Version: 01.11.12.00

Database Version: 17.0

RO

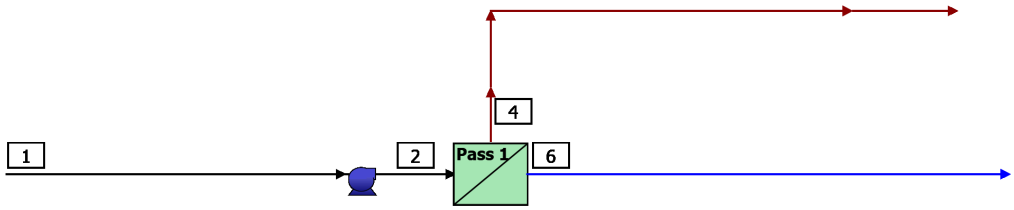
Project Name:	RARWTP
Case Name:	Long Term - 60 deg C
Customer:	
Prepared by:	Steven Coker
Company:	DuPont
Country:	
Date Created:	May 12, 2020
Project Notes:	
Case #:	3 of: 5
Case Notes:	Case 3
Keywords:	

Additional Feed Water Information

Stream 1: Added sulfate to balance feed water

RO Detailed Report

RO System Flow Diagram



#	Description	Flow (gpm)	TDS (mg/L)	Pressure (psi)
1	Raw Feed to RO System	1,288	636.3	0.0
2	Net Feed to Pass 1	1,287	636.5	118.4
4	Total Concentrate from Pass 1	257.8	3,076	85.4
6	Net Product from RO System	1,030	23.98	15.0

RO System Overview

Total # of Trains	1	Online =	1	Standby =	0	RO Recovery	80.0 %
System Flow Rate	(gpm)	Net Feed =	1,288	Net Product =	1,030		

Pass		Pass 1
Stream Name		Stream 1
Water Type		Well Water (SDI < 3)
Number of Elements		252
Total Active Area	(ft^2)	100800
Feed Flow per Pass	(gpm)	1,287
Feed TDS[a]	(mg/L)	636.5
Feed Pressure	(psi)	118.4
Flow Factor		0.80
Permeate Flow per Pass	(gpm)	1,030
Pass Average flux	(gfd)	14.7
Permeate TDS[a]	(mg/L)	23.98
Pass Recovery		80.0 %
Average NDP	(psi)	63.4
Specific Energy	(kWh/kgal)	1.34
Temperature	(°F)	60.0
pH		7.1
Chemical Dose		
RO System Recovery		80.0 %
Net RO System Recovery		80.0%

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Flow Table (Stage Level) - Pass 1

Stage	Elements	#PV	#Els per PV	Feed				Concentrate			Permeate			
				Feed Flow	Recirc Flow	Feed Press	Boost Press	Conc Flow	Conc Press	Press Drop	Perm Flow	Avg Flux	Perm Press	Perm TDS
			PV	(gpm)	(gpm)	(psi)	(psi)	(gpm)	(psi)	(psi)	(gpm)	(gfd)	(psi)	(mg/L)
1	NF90-400/34i	24	7	1,287	0.00	115.4	0.0	583.1	100.9	14.5	704.5	15.1	35.0	16.85
2	NF90-400/34i	12	7	583.1	0.0	97.9	0.0	257.8	85.4	12.5	325.4	13.9	15.0	39.47

RO Solute Concentrations - Pass 1

Concentrations (mg/L as ion)						
	Feed	Concentrate		Permeate		
		Stage1	Stage2	Stage1	Stage2	Total
NH_4^+	0.00	0.00	0.00	0.00	0.00	0.00
K^+	2.90	6.17	13.40	0.19	0.44	0.27
Na^+	33.00	70.52	153.8	1.96	4.55	2.77
Mg^{+2}	27.00	58.95	131.7	0.56	1.33	0.80
Ca^{+2}	102.0	222.8	497.8	2.06	4.89	2.95
Sr^{+2}	0.33	0.72	1.61	0.01	0.02	0.01
Ba^{+2}	0.10	0.22	0.49	0.00	0.00	0.00
CO_3^{-2}	0.31	1.66	9.01	0.00	0.00	0.00
HCO_3^-	310.3	674.1	1,492	7.65	17.89	10.87
NO_3^-	0.56	1.10	2.19	0.11	0.24	0.15
Cl^-	63.00	135.2	296.4	3.22	7.53	4.58
F^-	2.00	4.25	9.20	0.14	0.32	0.20
SO_4^{-2}	88.55	194.7	438.0	0.75	1.80	1.08
SiO_2	6.30	13.67	30.38	0.19	0.46	0.28
Boron	0.00	0.00	0.00	0.00	0.00	0.00
CO_2	35.01	35.59	38.63	35.03	36.23	35.43
TDS[a]	636.3	1,384	3,076	16.85	39.47	23.98
pH	7.1	7.4	7.7	5.6	6.0	5.8

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Design Warnings

None

RO Flow Table (Element Level) - Pass 1

Stage	Element	Element Name	Recovery (%)	Feed Flow (gpm)	Feed Press (psi)	Feed TDS (mg/L)	Conc Flow (gpm)	Perm Flow (gpm)	Perm Flux (gfd)	Perm TDS (mg/L)
1	1	NF90-400/34i	8.8	53.6	115.4	636.5	48.9	4.70	16.9	10.81
1	2	NF90-400/34i	9.2	48.9	112.4	696.6	44.4	4.50	16.2	12.33
1	3	NF90-400/34i	9.7	44.4	109.7	765.9	40.1	4.32	15.5	14.12
1	4	NF90-400/34i	10.4	40.1	107.4	846.7	36.0	4.16	15.0	16.25
1	5	NF90-400/34i	11.2	36.0	105.3	942.5	32.0	4.01	14.5	18.84
1	6	NF90-400/34i	12.2	32.0	103.6	1,058	28.1	3.89	14.0	22.04
1	7	NF90-400/34i	13.4	28.1	102.1	1,202	24.3	3.77	13.6	26.16
2	1	NF90-400/34i	9.3	48.6	97.9	1,384	44.1	4.50	16.2	24.15
2	2	NF90-400/34i	9.7	44.1	95.2	1,522	39.8	4.27	15.4	27.93
2	3	NF90-400/34i	10.2	39.8	92.9	1,682	35.8	4.06	14.6	32.48
2	4	NF90-400/34i	10.8	35.8	90.9	1,869	31.9	3.86	13.9	38.02
2	5	NF90-400/34i	11.5	31.9	89.2	2,090	28.2	3.67	13.2	44.88
2	6	NF90-400/34i	12.3	28.2	87.7	2,356	24.8	3.48	12.5	53.58
2	7	NF90-400/34i	13.3	24.8	86.4	2,678	21.5	3.28	11.8	64.90

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Solubility Warnings

Warning	Pass No
Langelier Saturation Index > 0	1
$BaSO_4$ (% saturation) > 100	1
CaF_2 (% saturation) > 100	1
Anti-scalants may be required. Consult your anti-scalant manufacturer for dosing and maximum allowable system recovery.	1

RO Chemical Adjustments

	Pass 1 Feed	RO 1st Pass Conc
pH	7.1	7.7
Langelier Saturation Index	-0.19	1.66
Stiff & Davis Stability Index	0.35	1.62
TDS[a] (mg/l)	636.3	3,076
Ionic Strength (molal)	0.01	0.07
HCO_3^- (mg/L)	310.3	1,492
CO_2 (mg/l)	35.00	38.62
CO_3^{-2} (mg/L)	0.31	9.01
$CaSO_4$ (% saturation)	2.0	25.7
$BaSO_4$ (% saturation)	268.7	2,370
$SrSO_4$ (% saturation)	0.61	4.0
CaF_2 (% saturation)	57.4	2,339
SiO_2 (% saturation)	5.9	28.6
$Mg(OH)_2$ (% saturation)	0.00	0.00

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Utility and Chemical Costs

Service Water

	Flow Rate (gpm)	Unit Cost ($/kgal)	Hourly Cost ($/h)	Daily Cost ($/d)
Non-Product Feed Water				
Pass 1	257.8	0.5300	0.01	0.14
Total Non-product Feed Water Cost	257.8		0.01	0.14
Waste Water Disposal				
Pass 1	257.8	2.6100	0.04	0.98
Total Waste Water Disposal	257.8		0.04	0.98
Total Service Water Cost				1.12

Electricity

Peak Power	(kW)	83.1
Energy	(kWh/d)	1,994
Electricity Unit Cost	($/kWh)	0.0373
Electricity Cost	($/d)	74.4
Specific Energy	(kWh/kgal)	1.34

Pump	Flow Rate (gpm)	Power (kW)	Energy (kWh/d)	Cost ($/d)
Pass 1				
Feed	1,287.44	83.08	1,993.94	74.40
Pass 1 Total Electrical Cost		83.08	1,993.94	74.40

Chemical

Chemical	Unit Cost ($/kg)	Dose (mg/L)	Volume (L/d)	Cost ($/d)
Total Chemical Cost				0.0

Utility and Chemical Cost	($/d)	75.5
Specific Water Cost	($/kgal)	0.051

WATER APPLICATION VALUE ENGINE

WATER SOLUTIONS

WAVE Program Version: 1.75.754

Calculation Engine Version: 01.11.12.00

Database Version: 17.0

RO

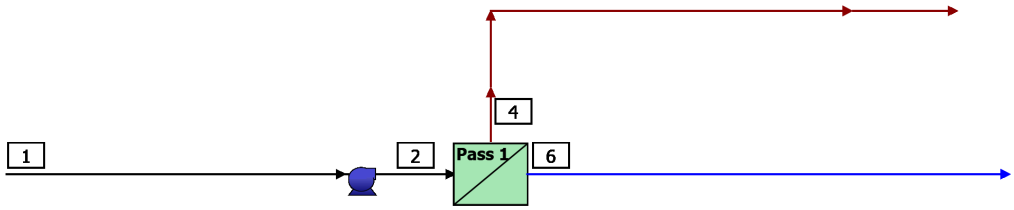
Project Name:	RARWTP
Case Name:	Long Term - 55 deg C
Customer:	
Prepared by:	Steven Coker
Company:	DuPont
Country:	
Date Created:	May 12, 2020
Project Notes:	
Case #:	4 of: 5
Case Notes:	Case 4
Keywords:	

Additional Feed Water Information

Stream 1: Added sulfate to balance water

RO Detailed Report

RO System Flow Diagram



#	Description	Flow (gpm)	TDS (mg/L)	Pressure (psi)
1	Raw Feed to RO System	1,288	636.3	0.0
2	Net Feed to Pass 1	1,287	636.4	127.2
4	Total Concentrate from Pass 1	257.6	3,093	92.8
6	Net Product from RO System	1,030	20.21	15.0

RO System Overview

Total # of Trains	1	Online =	1	Standby =	0	RO Recovery	80.0 %
System Flow Rate	(gpm)	Net Feed =	1,288	Net Product =	1,030		

Pass		Pass 1
Stream Name		Stream 1
Water Type		Well Water (SDI < 3)
Number of Elements		252
Total Active Area	(ft^2)	100800
Feed Flow per Pass	(gpm)	1,287
Feed TDS[a]	(mg/L)	636.4
Feed Pressure	(psi)	127.2
Flow Factor		0.80
Permeate Flow per Pass	(gpm)	1,030
Pass Average flux	(gfd)	14.7
Permeate TDS[a]	(mg/L)	20.21
Pass Recovery		80.0 %
Average NDP	(psi)	71.7
Specific Energy	(kWh/kgal)	1.44
Temperature	(°F)	55.0
pH		7.1
Chemical Dose		
RO System Recovery		80.0 %
Net RO System Recovery		80.0%

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Flow Table (Stage Level) - Pass 1

Stage	Elements	#PV	#Els per PV	Feed				Concentrate			Permeate			
				Feed Flow (gpm)	Recirc Flow (gpm)	Feed Press (psi)	Boost Press (psi)	Conc Flow (gpm)	Conc Press (psi)	Press Drop (psi)	Perm Flow (gpm)	Avg Flux (gfd)	Perm Press (psi)	Perm TDS (mg/L)
1	NF90-400/34i	24	7	1,287	0.00	124.2	0.0	582.8	109.0	15.3	704.7	15.1	35.0	14.19
2	NF90-400/34i	12	7	582.8	0.0	106.0	0.0	257.6	92.8	13.2	325.3	13.9	15.0	33.30

RO Solute Concentrations - Pass 1

Concentrations (mg/L as ion)						
	Feed	Concentrate		Permeate		
		Stage1	Stage2	Stage1	Stage2	Total
NH_4^+	0.00	0.00	0.00	0.00	0.00	0.00
K^+	2.90	6.21	13.58	0.16	0.38	0.23
Na^+	33.00	70.91	155.6	1.65	3.86	2.35
Mg^{+2}	27.00	59.08	132.3	0.47	1.12	0.67
Ca^{+2}	102.0	223.2	499.9	1.72	4.11	2.48
Sr^{+2}	0.33	0.72	1.62	0.01	0.01	0.01
Ba^{+2}	0.10	0.22	0.49	0.00	0.00	0.00
CO_3^{-2}	0.31	1.64	8.92	0.00	0.00	0.00
HCO_3^-	310.3	675.9	1,500	6.46	15.07	9.16
NO_3^-	0.56	1.12	2.26	0.10	0.21	0.13
Cl^-	63.00	135.9	299.4	2.71	6.38	3.87
F^-	2.00	4.28	9.33	0.12	0.27	0.17
SO_4^{-2}	88.55	194.9	439.0	0.63	1.51	0.91
SiO_2	6.30	13.72	30.57	0.16	0.38	0.23
Boron	0.00	0.00	0.00	0.00	0.00	0.00
CO_2	35.00	35.57	38.58	35.01	36.21	35.40
TDS[a]	636.3	1,388	3,093	14.19	33.30	20.21
pH	7.1	7.4	7.7	5.6	5.9	5.7

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Design Warnings

None

RO Flow Table (Element Level) - Pass 1

Stage	Element	Element Name	Recovery (%)	Feed Flow (gpm)	Feed Press (psi)	Feed TDS (mg/L)	Conc Flow (gpm)	Perm Flow (gpm)	Perm Flux (gfd)	Perm TDS (mg/L)
1	1	NF90-400/34i	8.7	53.6	124.2	636.4	49.0	4.66	16.8	9.19
1	2	NF90-400/34i	9.1	49.0	121.1	696.1	44.5	4.47	16.1	10.43
1	3	NF90-400/34i	9.7	44.5	118.3	765.0	40.2	4.31	15.5	11.90
1	4	NF90-400/34i	10.4	40.2	115.8	845.6	36.0	4.16	15.0	13.66
1	5	NF90-400/34i	11.2	36.0	113.7	941.6	32.0	4.03	14.5	15.80
1	6	NF90-400/34i	12.2	32.0	111.8	1,058	28.1	3.92	14.1	18.47
1	7	NF90-400/34i	13.6	28.1	110.3	1,203	24.3	3.81	13.7	21.91
2	1	NF90-400/34i	9.1	48.6	106.0	1,388	44.1	4.44	16.0	20.54
2	2	NF90-400/34i	9.6	44.1	103.2	1,525	39.9	4.23	15.2	23.67
2	3	NF90-400/34i	10.1	39.9	100.8	1,684	35.9	4.04	14.6	27.42
2	4	NF90-400/34i	10.8	35.9	98.6	1,871	32.0	3.86	13.9	31.99
2	5	NF90-400/34i	11.5	32.0	96.8	2,092	28.3	3.69	13.3	37.66
2	6	NF90-400/34i	12.4	28.3	95.3	2,359	24.8	3.51	12.6	44.87
2	7	NF90-400/34i	13.4	24.8	93.9	2,686	21.5	3.33	12.0	54.28

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Solubility Warnings

Warning	Pass No
Langelier Saturation Index > 0	1
$BaSO_4$ (% saturation) > 100	1
CaF_2 (% saturation) > 100	1
Anti-scalants may be required. Consult your anti-scalant manufacturer for dosing and maximum allowable system recovery.	1

RO Chemical Adjustments

	Pass 1 Feed	RO 1st Pass Conc
pH	7.1	7.7
Langelier Saturation Index	-0.23	1.62
Stiff & Davis Stability Index	0.32	1.59
TDS[a] (mg/l)	636.3	3,093
Ionic Strength (molal)	0.01	0.07
HCO_3^- (mg/L)	310.3	1,500
CO_2 (mg/l)	35.00	38.58
CO_3^{-2} (mg/L)	0.31	8.92
$CaSO_4$ (% saturation)	2.0	25.8
$BaSO_4$ (% saturation)	268.7	2,377
$SrSO_4$ (% saturation)	0.61	4.0
CaF_2 (% saturation)	57.4	2,408
SiO_2 (% saturation)	6.3	30.4
$Mg(OH)_2$ (% saturation)	0.00	0.00

Footnotes:

[a]Total Dissolved Solids includes ions, SiO_2 and $B(OH)_3$. It does not include NH_3 and CO_2

RO Utility and Chemical Costs

Service Water

	Flow Rate (gpm)	Unit Cost ($/kgal)	Hourly Cost ($/h)	Daily Cost ($/d)
Non-Product Feed Water				
Pass 1	257.6	0.5300	0.01	0.14
Total Non-product Feed Water Cost	257.6		0.01	0.14
Waste Water Disposal				
Pass 1	257.6	2.6100	0.04	0.98
Total Waste Water Disposal	257.6		0.04	0.98
Total Service Water Cost				1.12

Electricity

Peak Power	(kW)	89.3
Energy	(kWh/d)	2,142
Electricity Unit Cost	($/kWh)	0.0373
Electricity Cost	($/d)	80.0
Specific Energy	(kWh/kgal)	1.44

Pump	Flow Rate (gpm)	Power (kW)	Energy (kWh/d)	Cost ($/d)
Pass 1				
Feed	1,287.37	89.27	2,142.47	79.95
Pass 1 Total Electrical Cost		89.27	2,142.47	79.95

Chemical

Chemical	Unit Cost ($/kg)	Dose (mg/L)	Volume (L/d)	Cost ($/d)
Total Chemical Cost				0.0

Utility and Chemical Cost	($/d)	81.1
Specific Water Cost	($/kgal)	0.055

Attachment 5: **Installation Instructions & Contractor's Responsibilities**

Installation Instructions & Contractor's Responsibilities

Wigen will supply the equipment as skid mounted packages. Please see below for an overview of the Wigen supplied equipment and the contractor's responsibilities.

Nanofiltration Equipment – The NF skids will be skid mounted, fully assembled, Factory Acceptance Tested, and shipped to site assembled for installation by the Contractor. The Contractor will be responsible for all interconnect piping between the NF skids, connection to the Feed, Permeate, Concentrate, and CIP lines as well as all electrical connections to the Wigen supplied skids.

- The Skid Mounted Nanofiltration Trains will be provided will require no on-site assembly
- Each Train will require Contractor installation of the NF Membrane Elements, with Wigen assistance.

RARWTP Utility Connections (By contractor, each NF Skid)

NF Feed Inlet	10" 150# RF Flange
MCS Inlet	8" 150# RF Flange
Permeate Dump	8" 150# RF Flange
Permeate to Clearwell	8" 150# RF Flange
Permeate to CIP	4" 150# RF Flange
Concentrate to Waste	4" 150# RF Flange
Concentrate to CIP	8" 150# RF Flange
Sample Trough Drain	2.0" FNPT
Power Requirements	120 V / 1 Phase / 60 HZ / 15 A
Instrument Air Inlet	0.5" FNPT, 1 CFM @ 80 PSI Minimum

Water.
Process.
Solutions.

FAWTP UTILITY REQUIREMENTS & CONNECTIONS (by contractor, Each Skid)

NF Feed Inlet	10” 150# RF Flange
MCS Inlet	8” 150# RF Flange
Permeate Dump	8” 150# RF Flange
Permeate to Clearwell	8” 150# RF Flange
Permeate to CIP	4” 150# RF Flange
Concentrate to Waste	4” 150# RF Flange
Concentrate to CIP	8” 150# RF Flange
Sample Trough Drain	2.0” FNPT
Power Requirements	120 V / 1 Phase / 60 HZ / 15 A
Instrument Air Inlet	0.5” FNPT, 1 CFM @ 80 PSI Minimum

RARWTP & FAWTP CIP ITEMS TO BE SHIPPED “LOOSE”

- CIP Tank Level Instruments
- CIP pH Instruments and Transmitter
- CIP Temperature Indicator
- CIP Tank Heaters

FAWTP PERMEATE FLUSH SYSTEM ITMES TO BE SHIPPED LOOSE

- Permeate Flush Tank Level Transmitter

ITEMS TO BE SUPPLIED BY OTHERS

- Communications wiring from all NF skid Control Panels to the Master PLC/SCADA System.
- Power wiring to all PLC Panels and Remote I/O panels.
- Off-loading and installation of the skid systems and loose items (including membranes) required for full operation of the system.
- Installation of piping between skids.
- Air piping for instrument air to all skids.
- Skid Anchor Bolts.

Water.
Process.
Solutions.

Attachment 6: Spare Parts

Water.
Process.
Solutions.

Quality System Procedure

3E-160-F-TAG LIST

TAG LIST NUMBER:	

PROJECT NAME:	PROJECT NUMBER:
WARREN COUNTY, OH	TBD
SKID DESCRIPTION:	**ASSOCIATED P&ID DRAWING NUMBER:**
RENNEKER WTP SPARES	TBD

REV:	DATE:	CREATED BY:	DESCRIPTION OF CHANGES:
A	5/18/2020	BCC	FOR BID

SPARE PARTS:	QTY:	DESCRIPTION:	FUNCTION:	MANUFACTURER:	MODEL:
	2	COUPLING-1.50-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 1.5
	2	COUPLING-2.50-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 2.5
	2	COUPLING-3.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 3
	2	COUPLING-4.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 4
	2	COUPLING-6.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 6
	2	COUPLING-8.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 8
	2	COUPLING-10.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 10
	2	MEMBRANE HOUSING REPAIR KIT-WAVE CYBER	MEMBRANE HOUSING SPARES	WAVE CYBER	MEMBRANE HOUSING SERVICE PACK
	2	HEAD ASSEMBLY, 1-1/2" VIC, 300 SP	MEMBRANE HOUSING SPARES	WAVE CYBER	2080291
	80	ENCLOSURE, CORROSION INHIBITOR, 10CUFT, HOFFMAN, SPEC SECTION	ELECTRICAL SPARES	NVENT-HOFFMAN	AHCI10E
	120	FUSE, 0.5A, FAST-ACTING, 5X20, LITTELFUSE	ELECTRICAL SPARES	LITTLEFUSE	217.500
	1	SPARE CONDUCTORS, SPEC SECTION 40 9000 3.2,B,2	ELECTRICAL SPARES	MISC	MISC
	1	PLC, CONTROLLOGIX, PROCESSOR, 3MB, ETHERNET, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-L81E
	1	PLC, CONTROLLOGIX COMMUNICATIONS, ETHERNET, 2-PORT, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-EN2TR
	1	PLC, CONTROLLOGIX POWER SUPPLY, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-PA75/B
	1	PLC, CONTROLLOGIX I/O, 16-PT DI, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-IA16I
	1	PLC, CONTROLLOGIX I/O, 16-PT DO, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-OW16I
	1	PLC, CONTROLLOGIX I/O, 8-PT AI, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-IF8I
	4	PLC, CONTROLLOGIX I/O MODULE SCREW TERMINALS, 20-PIN, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-TBNH
	1	PLC, CONTROLLOGIX I/O MODULE SCREW TERMINALS, 36-PIN, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	1756-TBCH
	1	RELAY, SLIM LINE, DPDT, 120VAC COIL, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	700-HK32A1
	4	RELAY, SLIM LINE, DPDT, 24VDC COIL, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	700-HK32Z24
	5	RELAY, SLIM LINE, SOCKET BASE, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	700-HN222
	1	STRATIX 5700, 10 PORT MANAGED SWITCH	ELECTRICAL SPARES	ALLEN-BRADLEY	1783-BMS10CL
	1	PHOENIX CONTACT, TYPE 2 SURGE SUPPRESSOR, SINGLE PHASE,	ELECTRICAL SPARES	PHOENIX CONTACT	VAL-SEC-T2-1S-175-FM
	1	POWER SUPPLY, 24VDC, 480W, QUINT, 120VAC INPUT, PHOENIX CONTA	ELECTRICAL SPARES	PHOENIX CONTACT	2904602
	6	A-B 2711P-RGT15SP PANELVIEW PLUS 7 PROTECTIVE OVERLAY	ELECTRICAL SPARES	ALLEN-BRADLEY	2711P-RGT15SP

NOTES:

Water.
Process.
Solutions.

Quality System Procedure

3E-160-F-TAG LIST

PROJECT NAME:	PROJECT NUMBER:
WARREN COUNTY, OH	TBD
SKID DESCRIPTION:	**ASSOCIATED P&ID DRAWING NUMBER:**
RENNEKER WTP SPARES	TBD

TAG LIST NUMBER:	

REV:	DATE:	CREATED BY:	DESCRIPTION OF CHANGES:
A	5/18/2020	BCC	FOR BID

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Quality System Procedure

3E-160-F-TAG LIST

TAG LIST NUMBER:	

PROJECT NAME:	PROJECT NUMBER:
WARREN COUNTY, OH	TBD
SKID DESCRIPTION:	**ASSOCIATED P&ID DRAWING NUMBER:**
FRANKLIN WTP SPARES	TBD

REV:	DATE:	CREATED BY:	DESCRIPTION OF CHANGES:
A	5/18/2020	BCC	FOR BID

SPARE PARTS:	QTY:	DESCRIPTION:	FUNCTION:	MANUFACTURER:	MODEL:
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	2	COUPLING-2.50-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 2.5
	2	COUPLING-3.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 3
	2	COUPLING-4.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 4
	2	COUPLING-6.00-SS-GRV-K STYLE	FLEXIBLE COUPLING	PREMIER STAINLESS	K STYLE 6
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	2	MEMBRANE HOUSING REPAIR KIT-WAVE CYBER	MEMBRANE HOUSING SPARES	WAVE CYBER	MEMBRANE HOUSING SERVICE PACK
	2	HEAD ASSEMBLY, 1-1/2" VIC, 300 SP	MEMBRANE HOUSING SPARES	WAVE CYBER	2080291
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	1	SPARE CONDUCTORS, SPEC SECTION 40 9000 3.2,B,2	ELECTRICAL SPARES	MISC	MISC
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	1	RELAY, SLIM LINE, DPDT, 120VAC COIL, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	700-HK32A1
	3	RELAY, SLIM LINE, DPDT, 24VDC COIL, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	700-HK32Z24
	4	RELAY, SLIM LINE, SOCKET BASE, AB	ELECTRICAL SPARES	ALLEN-BRADLEY	700-HN222
	1	STRATIX 5700, 10 PORT MANAGED SWITCH	ELECTRICAL SPARES	ALLEN-BRADLEY	1783-BMS10CL
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	1	POWER SUPPLY, 24VDC, 480W, QUINT, 120VAC INPUT, PHOENIX CONTA	ELECTRICAL SPARES	PHOENIX CONTACT	2904602
	6	A-B 2711P-RGT15SP PANELVIEW PLUS 7 PROTECTIVE OVERLAY	ELECTRICAL SPARES	ALLEN-BRADLEY	2711P-RGT15SP

NOTES:

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3E-160-F-TAG LIST

TAG LIST NUMBER:	

PROJECT NAME:	PROJECT NUMBER:
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FRANKLIN WTP SPARES	TBD

REV:	DATE:	CREATED BY:	DESCRIPTION OF CHANGES:
A	5/18/2020	BCC	FOR BID

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Attachment 7: Deducts, Clarifications, Exceptions

Deducts & Value Engineering

Richard A. Renneker WTP (RARWTP)

Provide Hydranautics NF/RO elements instead of Dupont NF90: **- $75,600.00****

**NOTE: Hydranautics would not confirm that they could meet the specified performance guarantee/warranty, Dupont has confirmed that they can. We have reviewed both the ESPA4 elements and a Hybrid Hydranautics system. Also, the Hydranautics elements are higher rejecting elements than the Dupont NF 90 elements and may require higher feed pressures than Dupont. Which means long term OPEX, specifically pumping costs, will be higher over a 20 year period.

Franklin Area Water Treatment Plant (FAWTP)

Provide Hydranautics NF/RO elements instead of Dupont NF90: **- $ 43,050.00****

**NOTE: Hydranautics would not confirm that they could meet the specified performance guarantee/warranty, Dupont has confirmed that they can. We have reviewed both the ESPA4 elements and a Hybrid Hydranautics system. Also, the Hydranautics elements are higher rejecting elements than the Dupont NF 90 elements and may require higher feed pressures than Dupont. Which means long term OPEX, specifically pumping costs, will be higher over a 20 year period.

TO ALL DOCUMENT HOLDERS:

Subject: WCWSD RARWTP Membrane Softening Upgrades

AECOM Job No.: 60551697

Enclosed herewith is a copy of Addendum No. 4 covering the subject project.

Please retain this with your Documents.

Sincerely,

AECOM

Matthew Noelker, P.E.

Attachments:

Specifications

1. Section 00 4333 Proposed Products Form
2. Section 00 5215 Agreement Between Owner and Contractor
3. Section 00 7343 Wage Determination
4. Section 08 1114 Stainless Steel Doors and Frames

Drawings

1. Sheet PD-03
2. Sheet S-03
3. Sheet S-18
4. Sheet MP-01
5. Sheet MP-06
6. Sheet E-07

Equipment Procurement Documents

1. Equipment Procurement Contract Documents
    a. Drawings (Basis of OEM's bid)
    b. Specifications (Basis of OEM's bid)
    c. Addendum No. 1 (not posted to the above drawings/specifications)
    d. Addendum No. 2 (not posted to the above drawings/specifications)
2. OEM's Bid
    a. OEM's Bid Form (00 4113—Bid Form, completed)
    b. OEM's Scope of Supply
    c. OEM's Listing of Special Services
    d. OEM' Warranty
    e. OEM's Membrane Element Warranty
    f. OEM's Installation Instructions and Contractor Responsibilities
    g. OEM's Supplied Spare Parts
    h. OEM's List of Exceptions

Valve Schedule (excel format)

ADDENDUM TO THE
BIDDING DOCUMENTS
FOR:
WCWSD RARWTP Membrane Softening Upgrades

1.2 GENERAL

A. This Addendum covers changes to the Documents and in closing the Contract will become a part thereof. Each Bidder shall include these items to the extent they affect his Bid.

B. These items modify only the portion of the Documents specifically noted. All other wording and Drawings remain in effect.

1.3 NANOFILTRATION MEMBRANE EQUIPMENT SUPPLIER

A. Wigen Water Technologies has been selected as the nanofiltration membrane equipment supplier (OEM). Contractor is to purchase the nanofiltration membrane equipment from the OEM as part of this Contract and shall include all associated costs in their bid price. The Owner/Engineer is not purchasing this equipment on behalf of Contractor.

B. The OEM's pricing is included under the OEM's completed bid form (Section 00 4113—Bid Form). The Owner has selected the alternate bid of $2,555,451.00 (two million, five hundred fifty-five thousand, four hundred and fifty-one dollars and zero cents). Note that this bid form includes pricing for a different project as well—Contractor should only include pricing for the RARWTP Total Lum Sum Alternate Bid as part of their bid.

C. The OEM's timeline for deliverables is included under Article 5 of the completed Section 00 4113—Bid Form.

D. The Agreement for the purchase of the membrane equipment is included under Section 00 5215—Agreement Form. The terms and conditions of the agreement are included under Section 00 7000—General Conditions. Note that some of the condition included on the Agreement Form and in the General Conditions were modified as Part of Addendum No. 2 of the Equipment Procurement Documents.

E. Attached to this addendum are the following:
   1. Equipment Procurement Contract Documents
      a. Drawings (Basis of OEM's bid)
      b. Specifications (Basis of OEM's bid)
      c. Addendum No. 1 (not posted to the above drawings/specifications)
      d. Addendum No. 2 (not posted to the above drawings/specifications)
   2. OEM's Bid
      a. OEM's Bid Form (00 4113—Bid Form, completed)
      b. OEM's Scope of Supply
      c. OEM's Listing of Special Services
      d. OEM' Warranty
      e. OEM's Membrane Element Warranty
      f. OEM's Installation Instructions and Contractor Responsibilities
      g. OEM's Supplied Spare Parts
      h. OEM's Exceptions

1.4 CLARIFICATIONS

A. The following is a list of clarifications regarding project documents. These clarifications include questions received during the advertisement period:

C: Remove the C5 steel on the sill of the masonry opening and chamfer the edge of the CMU to allow the water to run off. See changes to the project drawings below.

Q: Please provide more detail (or an example) of what might be provided under Allowance A - Tools and Maintenance Equipment. The description indicates shall be full compensation for all tools and maintenance equipment (above and beyond that which is specified) to be used during construction.

A: This allowance is intended to cover any supplies, tools, or maintenance equipment the Owner determines they might need to operate the new facility.

Q: Allowance F - Security System, indicates it shall be full compensation for the security system scope of work to provide new equipment relative to the NF Building and West access gate and also for modifications of existing buildings' systems as shown on the drawings and as specified," but further indicates the "New equipment installation shall be provided under the Contractor's bid outside of this allowance." Please indicate what security equipment is to be installed in our base bid.

A: Under the allowance, the Security System Supplier will determine all the field devices. The Contractor shall provide conduits and wiring for field devices in the NF Building (reference Drawing Note E on Sheet E-08 and Drawing Note C on Sheet E-09). Reference Coded Note 9 on Sheet E-04 for West Access Gate equipment. Existing buildings' modifications shall all be performed by the Security System Supplier through the Allowance.

Q: Sheet A-12 appears to show all new FRP railing in the Chemical Feed Building, while sheet 2P-20 calls for most of the existing railing to remain and only few feet to be modified. Please advise what to follow?

A: Sheet 2P-20 is correct, reuse handrail and modify as required.

Q: Drawing 1P-05 shows all penetrations as WP-03, even though most of them are interior castings. Are WP-03 applicable for all penetrations shown on 1P-05?

A: Detail WP-03 states "provide flanged, mechanical joint, or plain ends as indicated in the drawings. Provide with tapped bolt holes." Contractor shall provide ends as piping requirements dictate.

Q: For WP-01 on sheet PD-01 can the contractor use a HDPE Century-Line type sleeve in lieu of the cast iron wall sleeve.

A: Provide the cast iron sleeve as specified.

Q: Section 01 3113 chemical building renovations, it states that 'work must be completed between November 1 and April 30' why is that? It also states that the 'existing chemical must be capable of being fed continuously and automatically' during the renovations. How is that supposed to be done?

A: The existing sodium hypochlorite and fluoride feed facilities must remain operational during construction. Outages of up to eight (8) hours are permitted. It is intended to perform work in these areas between November 1 and April 30 to coincide with the period of minimal water production by the WTP to provide the Contractor with the outage times that are required. The Owner and Engineer will work with the Contractor during construction on any proposed temporary feed system, but the facilities must remain operational and automated.

Q: Are the chemicals in the existing tanks to be transferred to the new tanks, and if so, is this by the Owner or the Contractor?

A: Existing chemical can be transferred to new tanks by Contractor and reused by Owner.

Q: Can this project be awarded if the lowest and best bid is over ten percent of the Engineer's opinion of probable construction cost?

A: Bids will not be awarded if over the engineer's estimate by 10% or more.

Q: Specification section 46 0630 gives specific quantities of chemicals that are to be supplied. Are these chemicals to be used for start-up and testing or is the contractor to supply chemicals in addition to these for start-up and testing?

A: These are chemicals for startup and testing and also for the Owner's initial supply.

Q: Specification Section 43 3225 paragraph 2.3.G states that the effluent nozzle, which is on the bottom of the Forced Draft Degasifier Tower is to be flanged. Typically, the nozzles on the bottom of these types of towers are plain end and the connection is made with a Dresser style of coupling. Please review and confirm that a flange connection is required.

A: Please refer to clarification regarding degasifier outlet connections in Addendum 3.

Q: Referencing the Room Finish Schedule on A-01, the Disinfection Chemical Room, Fluoride Room and Fluoride Pump Room are to receive a coating system for chemical feed areas. Please indicate what, if anything, needs done at the existing tank/equipment pads.

A: The exiting bulk tanks are conical bottom and are supported by piers. These piers are to be demolished per the structural drawings. New concrete surfaces and any surfaces that are damaged during construction are to receive the coatings indicated in the room finish schedule.

Q: Referencing the Room Finish Schedule on A-01, painted gypsum board ceiling (PT-GYP) is called out for the Chemical Room, Fluoride Room and Fluoride Pump Room ceilings. Please indicate if there is existing gypsum board that we are to remove and replace, if we are to install new gypsum board and paint, or if we are to only paint existing gypsum board.

A: The Gypsum board is existing and will only need painted.

Q: Addendum 3 stated that all pressure gauges to have Diaphragm Seal. GP-04 & GP-05 shows pressure gauge & pressure transmitter (PI-2132, PIT2132) connected as one a pressure assembly: Is the intent to have one diaphragm seal for both pressure transmitter & Gauge? Only the pressure gauge are have seal on it? Or each transmitter and gauge are to have a diaphragm seal?

A: A single diaphragm seal for location with both PIs and PITs is acceptable.

Q: GP-12 list FS-2202 as flow switch but Instrument schedule list as flow transmitter FIT-2002. Please clarify.

A: This is a flowmeter. Refer to dwg revisions for GP-12 and GP-04 in this addendum.

Q: Please reference drawing I-01. Is the communication cable and OIT in the Chemical Feed building DCC Enclosure to be bold or should it be ghosted?

A: The OIT and cable are bold. Those are new components to be provided in the existing Chemical Feed Building DCC Enclosure.

Q: For demolition purposes – approximately how much does the existing generator weigh?

A: Per the manufacturer's website it should be about 15,000 lbs.

Q: Please reference drawing E-04, Coded Note 7. Is this relocation of the Telecom Utility Pole covered under Allowance D "Local Utility Company" for the relocations of the existing Telecom Pole and Lines?

A: Yes.

Q: Please reference drawing E-04, General Note A. Is the Local Power Utility supplying and installing the concrete pad for their Main Power transformer?

A: No. The concrete pad would be provided by the Contractor. Detail would be per the Local Electric Utility Company.

Q: The following instruments are not located on the GP drawings, please clarify: LSH-6140, LSH-6240, LSH-6340, LSH-6440, LSH-6540, LSH-6640, TIT-1000, TIT-3000, TIT-6145, TIT-6245, TIT-6545.

A: These instruments are not part of the treatment process and therefore are not included on the Process Flow Schematics. They are shown on the electrical sheets.

Q : Drawing I-01 show modifications to multiple existing enclosures to add new Ethernet hardware. Can this work be combined in 1-2 trips or does each enclosure require a separate outage and only 1-2 enclosure work can be performed per day?

A : This topic will need coordinated through the Construction Manager and decided by the Owner during Construction. Assume a separate trip for each enclosure for bidding purposes.

Q : Spec 409443ATT schedule page 4 of 13 shows new I/O points for HSB010. Drawing I-01 doesn't show adding new PLC hardware. Is the intent to re-use existing spare I/O? Will the owner's programmer coordinate this work or is the SI responsible to perform this coordination? If the owner's programmer will coordinate the HSB work will the SI perform startup/loop check?

A : Existing spare points will be used for DI/DO/AI/AO terminations. A new RTD module will need to be added to accommodate the RTD inputs. Owner's programmers will determine available spare I/O points to terminate on. The System Integrator would be responsible for configuration, startup, and verification for all equipment/devices provided or modified by them in the High Service Building. The Owner's programmer would configure the RTD module.

Q: Spec 409443ATT schedule list multiple 'Ethernet Switch Alarm' as digital inputs to existing PLC. Is the intent to re-use existing spare I/O? Will the owner's programmer coordinate this work or is the SI responsible to perform this coordination?

A: Yes, the intent is to re-use existing spare I/O. The Owner's programmer will determine available spare I/O points to terminate on.

Q: Spec 409443ATT schedule pages 2, 3 show new Digital Output I/O - Drawing I-01 note 6 does not list the PLC Output module to use. Do the outputs require interposing relays or isolating fuses?

A: Which DO module/termination points to use are provided in the 40 9443 ATT I/O Schedule. All DO points to be used are existing. DO field wiring will just need terminated on existing terminal blocks.

Q: In the bid documents there is schedule 08 1113 Hollow Metal Doors and Frames & 08 1116 Aluminum Doors & Frames, but there is not such doors found in the drawings or the door schedule. Are these Specs relevant to this project?

A: These specifications are not relevant and are being removed from the project manual. See changes to the specifications below.

Q: Please confirm the size of the glass block window opening. The windows in A-06 are drawn as 10'-0"x4'-0", but the dimensions above call out 12'.

A: The glass block window openings are to be 12'-0" x 4'0" as shown on sheet A-06.

Q: Referencing the Glass Unit Masonry, multiple types of glass block are listed to be used. There are a few different product lines mixed in as one, which has created some confusion for our subcontractor. All of the types listed come in the wavy design called "Nubia": Premiere Standard - 1/4" thick glass per each face, and is rated for up to 45 minutes, using rated sealants at Head and Jambs; Thickset 60 - 3/8" thick glass per each face, and is rated for up to 60 minutes, using rated sealants at Head and Jambs; Thickset 90 – ¾" thick glass per each face, and is rated for up to 90 minutes, but must be within a steel frame at Head and Jambs and have rated sealants also.

A: Contractor shall provide Thickset 90.

Q: Section 31 2305, 1.4,C.2 says to obtain permits for excavation and fill work. What permits will be required here?

A: No permits will be required for excavation.

Q: Pressure transmitters PI2112, PI2132, PI2142, PI2162, PI3102, PI3302, PI3502, PI3202, PI3402, PI3602 on drawings GP-04 and GP-05 have the nomenclature of pressure gauges, but the instrument schedule has these marked as pressure transmitters. Please clarify if these instruments are to be pressure transmitters or pressure gauges.

A: Refer to Addendum 3. Some locations have both pressure indicators and pressure indicating transmitters with the same number.

Q: Specification section 40 05 23 paragraph 2.9.C has the requirements for the pressure gauges on the project. The air compressor specification and the chemical metering equipment specification sections state pressure gauges are to be provided by these equipment manufacturers, but there is no reference in these equipment specification sections to provide gauges as indicated in specification section 40 0523. Are all gauges supplied by equipment manufacturers supposed to meet the requirements in specification section 40 05 23?

A: Pressure gauges for the Compressed Air System and for the Chemical Peristaltic Metering Pumps do not need to meet the requirements as described in 40 0523 Process Valves, Gates, and Accessories.

Q: Are all pressure gauges supplied on the project supposed to be calibrated in the field or provide factory calibration documentation? Specification section 40 05 23 does not state any calibration requirements for the pressure gauges.

A: No field calibration is required.

Q: Does the Contractor have access to temporary utilities, including water and electric, at both sites?

A: Yes, the contractor will have access to temporary utilities, but the Contractor is required to provide per 01 5000—Construction Facilities and Temporary Controls.

Q: Specification 087100 DOOR HARDWARE, section 2.2.C.6, the finish for the mortise locks is specified as 32D. We have confirmed with Yale that they do not offer 32D for their locksets (they only offer a plated nickel finish (on zinc base metal) to simulate 32D). please confirm finish to be true 32D/we recommend Sargent 8200 LE1L in 32D.

A: The finish will be acceptable. Sargent will be evaluated as an “or equal” during the shop drawing review phase.

Q: Is the 30 day operational demonstration included in 40 9000—Plant Instrumentation and Control System General Requirements paragraph 3.6.B required to be completed prior to substantial completion?

A: Yes.

C: In a previous addendum, it was clarified that that the Contractor is responsible for temporary utilities through substantial completion. We are modifying this response such that the Contractor is responsible for temporary utilities up until the time that the new facility is producing treated water for the benefit of the Owner. This will occur prior to substantial completion due to the operational demonstration noted in our response above.

Q: We did not see a breaker/ panel schedule for the new circuits from existing Power Panels PP1 and PP2 to the new equipment. Do we use spare breakers or existing breakers available from equipment that has been removed?

A: Correct. New circuits will be fed from existing breakers, either existing spares or ones available after removing existing equipment.

Q: Please indicate if we are permitted to utilize the drive that runs from the treatment plant back to the outfall area.

A: Yes, this drive can be used for access to the outfall area.

Q: On drawing E-06 (Basement Power Plan) a control panel is identified as "MEMBRANE CLEANING SYSTEM CONTROL PANEL". This control panel indicates 4 conduits exiting to field devices, 1 conduit is identified the other 3 are not. Please provide conduit and cable designation for the other 3 conduits.

A: Refer to Addendum 2.

Q: On drawing E-05, Note 2 "refer to conduit and wire schedule for continuation of conduits". There are no conduit and cabling designations listed for the continuation of these. Please identify conduit size and fill for conduits extending to the electrical room from this enclosure.

A: The P and L conduit numbers did not change as they passed through the electrical pullboxes. Conduit size and fill are still as identified in the Conduit and Wire Schedule.

Q: On drawing E-05 please indicate the size of the bare ground wire to be used for the grounding loop.

A: The bare ground conductor for the station ground system shall be #4/0.

Q: On drawing E-07 no information is shown for the field end of the Hoist/Trolley Control Panel. Please indicate what conduit and cabling will be required for power and control of this equipment.

A: The field side requirements are specified to be coordinated with the Electrical Contractor by the Hoist/Trolley System manufacturer once a manufacturer is approved.

Q: Referencing addendum #2, a question was asked if excess spoils can remain onsite at both the outfall and the treatment plant. The response specifically indicated that spoils cannot be left at the outfall and will need to be hauled offsite, but does not make mention of allowing spoils to remain onsite for the treatment plant. We interpret this to mean that spoils for the treatment plant can remain onsite. Please indicate if this interpretation is incorrect.

A: Spoils can remain onsite at the treatment plant site to the extent required for grading purposes as shown on the Civil Sheets. Excess soil beyond this will be required to be disposed of offsite.

Q: Referencing drawing 2D-20 we are to demolish the existing Hypochlorite tanks. Drawing 2P-20 indicates equipment pads under all of the new tanks. Please indicate if there are existing equipment pads under the existing tanks that can be utilized, or if all pads shown on 2P-20 are new.

A: All tank pads are new. Existing tanks are conical bottom. Existing tank supports to be demolished as shown on the structural sheets.

Q: Drawing S-18 provides dimensions for the generator pad as 51' long x 20 wide. Drawing C-13 shows the generator pad with a side walk on the North end. Scaling drawing C-13, the generator pad + sidewalk is 51' length. Please verify the length of the generator pad. If the generator pad is to remain 51' long, please indicate if we are to have a sidewalk in addition to the 51' generator pad.

A: For bidding purposes, the generator pad is 51' long and 20' wide. Final dimensions may vary slightly depending on approved equipment (See asterisks and General note 8, drawing S-01). C-13 also shows sidewalk north of the generator pad. For bidding purposes assume the sidewalk is 9' long and 20' wide. Final dimensions of the sidewalk may also vary depending on approved equipment. The generator assumed for design will overhang its equipment pad. The sidewalk is intended for the area underneath the overhang.

Q: Project specification 31 2305 Excavation and Fill, section 2.1 A Select Fill, calls out that Select Fill shall be Item 304 material. Contract drawing S-16 shows a typical concrete wall backfill detail which indicates that all below grade structures with backfill on one side and liquid or open on the other side shall be backfill with compacted select fill. Please verify that the contractor is to price backfilling the exterior walls of all structures with granular material.

A: Basement and buried walls shall be backfilled with select fill material as required by Section 31 2305 and Table 31 2305-A, with the exception of the perimeter drain, which shall follow detail "3" on sheet C-02. Excavated materials may be used as select fill if in compliance with Section 31 2305-3.5.J.

Q: Referencing SECTION D/A-09, please indicate how the eave strut is to be attached to the building. Typically, the eave strut would be attached to the PEMB, however, given the indicated height of the masonry wall, we will be unable to attach the purlin to the structural frame.

A: This detail is within the PEMB manufacture delegated scope of work. In the past, we have seen the eave strut attached to the structure by use of beams extending from the frame.

Q: Referencing drawing A-04, the masonry wall along column line 6 is to go full height, to the upper eave which is above the roof of the control/mechanical/electrical room portion of the building. Referencing SECTION E/A-10, no details are provided on how the roof purlins are supported. In order for purlins to be supported off of the structural steel along column line 6 we would have to penetrate the masonry wall every purlin. Another option is to install a secondary frame to the east of the masonry wall on column line 6, however, this will cause interference issues with the doorway(s). Another option would be to mount supports on the masonry wall the carry the weight of the purlins, but design would need to be provided. Please provide direction.

A: The roof purlins will be connected to the frame on column line 6 and penetrate the masonry wall. Voids shall be filled with mineral wool, similar to details shown on sheet A-16. For fire wall penetrations, follow details on sheet A-15.

Q: There are numerous requirements throughout the specifications for seismic design requirements to be provided, based on the requirements of the project's location. Per Drawings S-01, this project is located in a category C area. Based on the Category C designation, electrical and mechanical components should be exempt from seismic requirements per ASCE Chapter 13. Please confirm that electrical and mechanical components do not require seismic design calculations and requirements.

A: No. ASCE 7-10 13.1.4 exempts seismic design of all electrical and mechanical components that have an importance factor of 1.0. Components with importance factors higher than 1.0 are under ASCE 7-10-13.1.3, and would include sprinkler systems, components containing, transporting, conveying toxic, highly toxic and explosive substances, such as the chemical tanks and associated equipment that fall into the above category).

Q: Do the plumbing sanitary lines on Sheet MP-01 get encased in concrete per Detail 2 on Sheet C-02? We assume this piping is below the basement mat foundation.

A; Yes, all pipes below the slab shall be encased. A new detail “Plumbing Pipe Encasement Detail” has been added to revised sheet S-18. Sheet MP-01 is being revised and reissued as an attachment to this Addendum.

Q: There are precast planks being supported by components of the pre-engineered metal building at the west end over the chemical rooms. Please provide anticipated dead and live loads for these planks so the beams supporting these can be properly sized.

A: Precast Planks will be designed for a 40 PSF LL, and 20 psf collateral load. See Sheet S-01 revisions per this addendum.

Q: Please confirm slag grade 100 is acceptable in lieu of grade 120 per specification 03 3300 2.2 C. 1.

A: Contractor shall submit a substitution request to use grade 100 in lieu of grade 120 that includes an explanation of the substitution. Bid shall be based on grade 120.

Q: Please confirm Penetron is an acceptable alternate to Xypex waterproofing admixture in specification 03 3300 2.5 K. 2. b.

A: It is the onus of the contractor to prove a product is an "Or Equal" in accordance with contract substitution requirements. However, if the product meets the specification as an "Or Equal", Contractor may submit shop drawing for review and approval. Engineer makes no assessment in favor or against at this time.

Q: In Section 03 3000 please clarify which concrete class mixes and locations are to have shrinkage reducing admixture and please clarify which concrete class mixes and locations are to have Crystalline Waterproofing Admixture. The stated requirement to meet .035 or .030 are very stringent for this region without requiring shrinkage reducing admixture.

A: The shrinkage reducing admixture use is specified under Section 03 3000, paragraph 2.6.G, in order to meet the shrinkage requirements. The location of the use of the crystalline waterproofing admixture mix as in section 03 3000, paragraph 1.1.C.6. The use of a shrinkage reducing admixture is not mandatory.

Q: In regard to section 03 3000, paragraph 1.3.B, We request this paragraph be changed to follow the ASTM C157 requirements, without modification.

A: The paragraph shall remain as is.

Q: Referencing details C,D/A-10 and B,C,D/A-11, a hook bar is shown connecting the masonry wall to the precast plank, that is embedded in the bond beam of the masonry wall, comes out the side of the masonry block, and continues into the hollow core of the precast plank. We are unclear on how it is possible to install this bar. Please provide a revised detail.

A: Reinforcing bar to be placed at 4-ft intervals in the joints of the precast plank. This is a standard precast plank detail.

Q: Please provide dimensions of the exterior approach slabs and other concrete stoops around the perimeter of the Softening Building. Do all exterior concrete pads around the Softening Bldg as shown on S-03 have supporting walls as shown in the Approach Slab detail F/S-04?

A: Please see Section F/S-04; B/S-05; C/S-08. In general, stoops are the same width of the sidewalk (5'-0") and 6" wider than the door on each side. A note "7" will be added to Drawing Refer to revised Sheet S-03, reissued as part of this addendum.

Q: Are the sump pits in rooms R107, R108, R109 and in the Chemical Feed Building to be covered with any grating? None is shown on detail B/S-04 & E/S-14. If so, please provide detail.

A: No, the sump pits need not be provided with grating.

Q: What material are the stairs and handrail in Rooms R107, R108, and R109? We can't find it called out on any of the drawings.

A: Railing and stairs in chemical rooms are FRP, see FRP stair detail on Sheet A-17. All locations outside of chemical feed areas shall be aluminum.

Q: Please provide the pilaster/peir sizes for the Chemical Room area along column lines 1 and 2.

A: Pilaster denominations have been added to revised sheet S-03, reissued as part of this addendum.

Q: In spec section 32 9200 and 32 9300 sections it goes into great detail describing very specific topsoil requirements and a planting section. Sheets C-13 an C-14 are the only plans with any seeding shown. With the elaborate Turf and Planting specs and such little information on the plans are we missing a sheet or two or is there more information forthcoming on some more drawings ? Is the Topsoil to be 8" thick as stated in the specifications? Who pays for all the testing of the soils as called out in the specifications?

A: No additional drawings are forthcoming. Provide 8" thick topsoil. Testing shall be paid by the Contractor.

Q: The Demo plans C-09 does not match the new asphalt areas show on pages C-13 and C-14. Please confirm all the existing asphalt in the proposed asphalt areas is to be removed and hauled offsite.

A: The location of the drive access southwest of the NF building is shifting from its existing location to the east. The hatch on C-09 is denoting the area of existing pavement that is outside the boundary of the proposed pavement. Full depth pavement replacement is required in all areas shown for new pavement (except a small portion near the lift station). For much of the area, the amount of excavation for the proposed piping necessitates full depth removal.

Q: We interpret SAN MH 2 shown sheet C-23 is an existing MH. Please confirm our understanding is correct.

A: There is an existing manhole in the location of SAN MH 2. However, due to how close the existing manhole is to the proposed 42" GFE, the Contractor is to replace the existing manhole. Note, the proposed SAN MH 2 shall have additional depth so it is not bearing on the proposed 42" GFE, and the additional depth will be filled up to the invert elevations as indicated.

Q: What is the current flow rate through the 8" SAN line?

A: Flow cannot exceed the downstream lift station pump which is 80 gpm. Flow was 6.6 gpm during a test of the lift station in August 2019 and this flow is assumed to be typical.

Q: What is the required diameter for SAN MH 1?

A: SAN MH 1 is a typical 4' inside-diameter manhole.

Q: Please refer to sheet C-18. What is the elevation of the existing 36" FW line running parallel to the 30" WM line?

A: Records indicate that the centerline elevation of the existing 36" FW line is 746.83 at the connection to both clearwells and 749.00 near the branches to the high service pumps (the pipe going south that runs along the west side of the High Service Pump Building). Contractor shall field verify depths.

Q: In reference to Sheet C-18, what is the maximum allowable time the contractor will be given to tie-in the new BLW line to the existing WM line?

A: This connection would fall under Section 01 3113, Part 1.3.B.2 for shutdown of treated water delivered to the clearwells.

Q: In specification section 01 3113 paragraph 1.3.B there are several shut-downs listed for pipe tie-in work. Assuming the tie-in work can be accomplished within the allowable shut-down duration will any bypass pumping be required? Can the Owner isolate each area where there the only requirement would be for some minor draining of the lines involved in the shut-downs?

A: If the tie-in work can be accomplished within the allowable shut-down duration, then no bypass pumping will be required. Except for the red water filter effluent, tie-in locations can be isolated so only draining of lines are involved in the shut-down; the red water filter effluent will require a gravity sewer plug upstream of the proposed sample vault location to prevent draining of the red water filters. However, draining of the red water filters would be acceptable so long as they are not out of service more than 16 hours. If bypass pumping is preferred for the red water filter effluent the flowrate is 35-60 gpm. Red water filter effluent may be discharged into any existing downstream storm structured through which it currently flows, or to the proposed detention basin if the detention basin effluent is installed.

Q: Per the Note #3 on sheet C-09, are we correct to understand the sample MH on this sheet is used to sample the Red Water Effluent? Is it correct to assume Red Water Effluent from the existing tanks must be maintained through this manhole until new permeant improvements are made to send it through the new Detention Basin?

A: Correct, the sample MH called out on C-09 is currently used for sampling the red water filter effluent. Sampling of the red water filter effluent is only once a month and it is flexible. It should not have a large impact the construction sequencing, but it does need to be considered in the coordination with the Owner. Interim sample locations after the demolition of the ex sample MH and before the construction of the proposed sample vault on C-19 are acceptable if needed as long as the flow is not being diluted by other water sources.

Q: On Sheet No. C-21 there are two pipe tie-ins to the existing 8" Water Main that require tapping sleeves and valves. To the west on the same line that line is rerouted. If the line can be shut down to tie-in the rerouted line why are the hot taps required? The Owner can isolate this area, correct? What is the longest acceptable outage for this line?

A: Shutdowns for rerouting the 8" waterline to the west are limited to two 4-hour shutdowns. The Owner can isolate this area. The connection for the pipe to the south wall of the NF Building may be made by cutting in a tee in lieu of a tapping sleeve if this work is performed during a shutdown for the rerouting of the 8" waterline (i.e. additional shutdown time will not be given). Provide a tapping sleeve and valve for the line connecting to the east wall of the NF Building (isolation for this location is separate from the line farther west).

Q: Can the Owner isolate the PW Line for the tie-ins as shown on Sheet No. C-22? What is the longest acceptable outage for this line?

A: The Owner can isolate the PW line shown on C-22. Shutdowns for this line are limited to 8 hours. This line is looped and can be fed from either the south or the east.

Q: Dwg C-13 Note 1 says to adjust existing manholes and valve boxes to grade. Which items will need to be adjusted?

A: This would include but not be limited to a few valve boxes in the area north of the High Service Pump Building (minimal adjustment, if any needed), the sanitary manhole downstream of proposed SAN MH 1 (raise 3"±), and a number of valve boxes and electrical manholes south of the NF building (raise in the range of 3"± to 16"±).

Q: We noted at the Pre-bid meeting that the existing fence has a continuous grounding wire at the base of the fabric. Please confirm that the new fencing should include a grounding wire.

A: Provide ground wire. Refer to the paragraphs added to Section 32 3100, Part 2.9.

Q: Please confirm that there is a Type 6 Curb per C-04 around all sidewalks of the Softening Bldg. If not, please identify where curb limits start and stop.

A: There is curb around all of the sidewalks around the NF Building except the curbs do not pass through the concrete slabs at the doors. Near overhead doors the asphalt is even with the concrete so the curb reveal will be small.

Q: The concrete lined channel detail (1/C-13) is not dimensioned as to what elevation the top is to be poured to in the Detention Basin. Is it to be poured in the entire Detention Basin to elev. 759.00 or just in the bottom to elev. 754.00?

A: Refer to the North Storm Profile on sheet C-24. The channel invert will match pipe inverts on each end: 752.31 on the downstream end and 753.88 on the upstream end. Provide a constant slope. Provide a uniform depth of 6" from invert to top of concrete for the length of the channel.

Q: Please provide dimensions of the exterior approach slabs and other concrete stoops around the perimeter of the Softening Bldg.

A: Refer to Section F on sheet S-04.

Q: Does standard clean out detail on C-02 also apply to the foundation drain clean outs, or can they be constructed of PVC?
A: Foundation drain cleanout piping shall be of the same material as the foundation drain.

Q: Can non-structural steel, or miscellaneous metals, be supplied by a non-AISC shop?
A: Miscellaneous metals that do not involve shop welding may be fabricated by a non-AISC Shop. Shop welded and all structural steel fabrications shall be supplied by an AISC certified shop to avoid the requirement to provide special inspection at the shop.

Q: Details F and G on S-05 show a formed concrete trench drain with a grouted bottom and aluminum grating. However, the MP-02 shows a prefabricated trench drain that is called out in specification 22 0010, 2.05.G to be a Zurn or Acco product. Please clarify which is correct.
A: For bidding purposes, Contractor shall assume the product specified under 22 0010 2.05.G is required.

Q: Can the valve schedule shown on the GP sheets be provided in excel format?
A: Yes—the valve schedule is being provided as an attachment to this addendum. Note this is being provided as a courtesy and does not affect the schedules listed in the bid documents. In the case of any discrepancies, the schedule on the GP sheets should be followed.

1.5 PROJECT MANUAL

A. Section 00 0100 Table of Contents
   1. Delete “08 113 Hollow Metal Doors and Frames”
   2. Delete “08 1116 Aluminum Doors and Frames”
   3. Add “08 1114 Stainless Steel Doors and Frames”

B. Section 00 4333 Proposed Products Form
   1. This section is being revised and reissued as an attachment to this addendum.

C. Section 00 5215 Agreement Between Owner and Contractor
   1. This section is being revised and reissued as an attachment to this addendum.

D. Section 00 7343 Wage Determination
   1. This section is being revised and reissued as an attachment to this addendum.

E. Section 01 2100 Allowances
   1. Paragraph 1.2.D – Delete “labor, installation costs”

F. Section 02 6500 Underground Storage Tank Demolition
   1. Paragraph 1.3.E – Delete the following text:
      a. “and General Specifications 02105 and 02316”.
   2. Paragraph 3.1.D – Add the following text to this paragraph:
      a. “Contractor shall include 100 gallons of excess liquid removal and disposal in their bid.”

3. Paragraph 3.2.A – Add the following text to this paragraph:
   a. "Contractor shall include 10 CY of contaminated soil disposal in their bid."

G. Section 03 3000 Cast-In-Place Concrete
   1. Paragraph 2.6.G.1 – Replace "… age shall not exceed 0.035 percent and 0.005 percent, respectively." with "….age shall not exceed 0.035 percent and 0.045 percent, respectively."

H. Section 08 1114 Stainless Steel Doors and Frames
   1. This section is being added and issued as an attachment to this addendum.

I. Section 08 1113 Hollow Metal Doors and Frames
   1. Delete this section from the project specifications.

J. Section 08 1116 Aluminum Doors and Frames
   1. Delete this section from the project specifications.

K. Section 08 3323 Overhead Coiling Doors
   1. Paragraph 2.4.D.2 – Delete this paragraph.

L. Section 22 0010 Plumbing Systems
   1. Paragraph 2.5.G.1.a – Modify the following text to read:
      a. "a. Zurn Model Z890-DGC."
   2. Paragraph 2.5.G.6 – Modify the following text to read:
      a. "6. Provide ductile iron slotted grates, Zurn P6-DGC, 20-in. x 5-3/8-in., conforming to DIN rating Class C, ANSI rating of Heavy-Duty, H-20 load rated and ASTM A536 Grade 80-55-06. Grates shall lock down to frame."
   3. Paragraph 2.5.H.1.a – Modify the following text to read:
      a. "Zurn Model Z706-HDS-DGC."
   4. Paragraph 2.5.H.5 – Modify the following text to read:
      a. "5. Grate: Provide ductile iron slotted grate, Zurn DGC, supplied in 20-in nominal lengths with 5/16 in wide slots and ¾-in bearing depth, conforming to DIN rating Class C, ANSI rating of Heavy-Duty, H-20 load rated and ASTM A536 Grade 80-55-06."
   5. Paragraph 2.14.B.4 – Modify the following text to read:
      a. "4. Duplex Pump System (SP-1 and SP-2):
         1) Zoeller high head submersible effluent pumps. Rated for continuous duty and capable of passing 1/2 in. solids. Shutoff head at least 50% greater than TDH at scheduled rated flow.
            a. SP-1 (LEAD Pump): Model 151 - Rated for continuous duty at 29 gpm against 20 ft TDH and capable of passing 1/2 in. solids. 1/3 horsepower at 3450 rpm, 115 Volts, single phase.
            b. SP-2 (LAG Pump): Model 161 - Rated for continuous duty at 79 gpm against 20 ft TDH and capable of passing 1/2 in. solids. 1/2 horsepower at 3450 rpm, 115 Volts, single phase.
         2) Pump Control Settings:

1) 6" Drain Invert EL.	741.50
2) High Water Alarm EL.	743.00
3) Both Pumps On EL.	742.00

4) Lead Pump On EL. 741.50
5) Both Pumps Off EL. 741.17
6) Bottom of Sump EL. 740.50"

6. Paragraph 3.5.D – Modify the following text to read:
   a. "D. Install insulation on domestic hot, cold and tepid piping."
7. Paragraph 3.5.E. – Modify the following text to read:
   a. "E. Provide PVC jacketing with formed fitting covers on all plumbing piping systems located within chemical room spaces and everywhere else where plumbing piping systems are exposed and located within 8-ft above finish floor."
8. Paragraph G.2.a – Modify the following text to read:
   a. "a. Insulation: Fiberglass with vapor barrier jacket (above grade) (PVC over-jacket where exposed and located within 8-ft above finish floor."
9. Paragraph H.1 – Modify the following text to read:
   a. "H. Hot and Tepid Piping (85ºF to 200ºF):
      1) Application Requirements: Insulate following hot and tepid piping systems.
         a. Domestic hot water piping systems.
         b. Domestic hot water return piping systems.
         c. Domestic tepid water piping systems."
10. Schedule 1 to section 22 0010 to read the following:

SCHEDULE 1 TO SECTION 22 0010
Insulation Thicknesses in In. for Pipe Sizes

Piping System Types	Fluid Temp. Range °F.	Runouts up to 2 in. (2)	1 in. and Less	1-1/4 to 2 in.	2-1/2 to 4 in.	5 to 6 in.	8 in. and Larger
Hot & Tepid Systems:							
Low Temp.	85-200	1	1	1	1-1/2	1-1/2	1-1/2
Cold Systems:							
Plumbing	Any	3/4	3/4	1	1	1	1

M. Section 23 0700 HVAC Insulation
1. Paragraph 2.5 – Modify the following text to read:
   a. "E. PVC Jacket Material:
      1) PVC roll jacketing, 20 mil (0.5 mm), high impact UV-resistant polyvinyl chloride, inherent vapor retarder and protection to insulated pipes, designed to fit seamlessly over fitting coverings, Johns Manville, Zeston PVC Jacketing or equal."
2. Paragraph 3.2.B – Modify the following text to read:
   a. "B. Cold Piping (40ºF to 65ºF):
      1) Application Requirements:
         a. Geothermal/raw water piping systems associated with WSHP's.
         b. Condensate drain piping.
      2) Insulate each piping system specified above with the following types and

thicknesses in accordance with Schedule 1.

a. Fiberglass (FGP-1) Insulation with Type JK-2 jacket. (Geothermal/raw water piping)
b. Fiberglass (FGP-1) Insulation with Type PVC jacket. (Geothermal/raw water piping exposed and located within 8-ft above finish floor)
c. Flexible Unicellular Insulation (UP-1). (Condensate drain piping only)"

N. Section 32 3100 Fences
1. Part 2 – Include the following text as paragraph 2.9 FENCE GROUNDING:
A. Conductors: Bare, solid wire for No. 6-gage and smaller, stranded wire for No. 4-gage and larger.
1. Material Above Finished Grade: Copper.
2. Material On or Below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, one inch wide, woven of No. 30-gage bare copper wire, terminated with copper ferrules.
B. Connectors and Ground Rods: As listed in UL 467.
1. Connectors for Below-Grade Use: Exothermic welded type.
2. Ground Rods: Copper-clad steel.
a. Size: 5/8-inch by eight feet.

O. Section 40 0513 Process Piping
1. Paragraph 2.4.A.4 – Modify the following text to read:
a. "Support: Tubing shall be supported by 3-inch diameter schedule 80 PVC carrier piping. Each chemical shall be supported in a separate carrier pipe. No fittings shall be provided on the carrier pipe to facilitate installation of future tubing."

P. Section 40 0523 Process Valves, Gates, and Accessories
1. Paragraph 2.3.A.2 – Add the following text:
a. "e. Engineer Approved Equal."

Q. Section 43 2100.02 Vertical Turbine Pumps and Appurtenances
1. Paragraph 2.10.B.4 – Modify the following text to include "… or Engineer Approved Equal."
2. RARWTP PUMP SCHEDULE – Modify the following schedule to include:
a. "Maximum Suction Can Pressure: 75 psi"

R. Section 46 6320 Cartridge Filtration Equipment
1. Paragraph 2.3.A.1. Delete this paragraph and replace with the following:
Filter vessels shall be designed and constructed in accordance with any of the following three standards for FRP cartridge filter housings: ASME Boiler and Pressure Vessel Code Section X, The European EN13121 code or the German Ad Merkblatt code. The vessels shall have a stainless steel nameplate stamped with the filter model number, the quantity and number of filter cartridges and the equipment number. The vessels shall be designed for use with cartridges that are of common size available from at least two or more manufacturers.
2. Paragraph 2.3.B.2. Delete "FRP" and replace with "PVC/PA/PE/PP/FRP".
3. Paragraph 2.3.B.3. Delete "FRP" and replace with "PVC/PA/PE/PP/FRP".

4. Paragraph 2.3.B.9. Delete "316 SST" and replace with "FRP".
5. Paragraph 2.3.C.1. Delete this paragraph and replace with the following:
   "All the wetted components shall be designed and manufactured of non-corrosive materials. The main body and component material shall be made out of fiberglass reinforced polyester. The cartridge filter housing shall be provided with a deflector plate after the inlet. The deflective plate shall be made from FRP and be an integral part of the cartridge filter housing. A guide plate shall be part of the internal design, to assure perfect cartridge alignment and separation."
6. Paragraph 2.3.C.2. Delete this paragraph and replace with the following:
   "Cartridge Supports: The filter housing shall employ a reinforced internal cartridge support rod made from FRP and/or other corrosion resistant materials, designed for double-open-end (DOE) connection of the cartridge elements. The sealing of each cartridge element shall be ensured by a knife-edged seals in both ends, at the bottom and at the tightening nut at the top."
7. Paragraph 2.3.C.3. Delete this paragraph and replace with the following:
   "The opening system gasket shall be Kroll & Ziller type."
8. Paragraph 2.3.C.4. Delete this paragraph and replace with the following:
   "Horizontal filter vessels shall have a removable internal cartridge alignment support plate located in a manner to prevent cartridge movement. The housing shall have a system to individually seal each double open end cartridge, before closing the housing."
9. Paragraph 2.4.A.1. Add "(for single open end cartridges)"
10. Paragraph 2.4.B. Add "Piedmont" as an acceptable manufacturer.

S. Section 46 6340 Nanofiltration Membrane Equipment
1. Paragraph 2.1.C.1. Delete and replace with the following:
   "Wigen Water Technologies."
2. Paragraphs 2.2.A.1. Delete and replace with "304 SST."
3. Paragraph 2.2.A.2. Delete this paragraph.
4. Paragraph 2.3. Add the following as subparagraph G:
   "Velocities in piping shall not exceed 9 feet per second except in control valves or flow metering sections."
5. Paragraph 2.8.A – Revise "floor-mounted where indicated by the Drawings, adjacent to each skid" to read "mounted on the skid".
6. Paragraph 2.9.F.1 – Delete the following:
   "Conduit and wiring between instrumentation and MCS shall be provided by OEM. Conduit and wiring shall comply with Division 26 and 409XXX series specifications." This conduit and wiring will be provided by the General Contractor.
7. Paragraph 2.10.A – Delete this paragraph.
8. Paragraph 2.11.A.2 – Add the following to this paragraph:
   "SDI test apparatus shall consist of an isolation valve, pressure reducing valve (hand-operated, design to regulate from up to 150 psi to 30 psi), and an SDI pad holder."
9. Paragraph 2.11.A.3 – Revise to read as follows:
   "Provide 500 filters for each WTP."
10. Paragraph 2.16.C. Add the following as subparagraph 8:
    "Operator shall have the ability to enter the desired maximum flux for stage 1 of the membrane array. The stage 1 permeate throttling valve shall be automatically controlled to maintain this maximum flux rate."
11. RARWTP RO Membrane Equipment Schedule:
    a. Table 1 – RARWTP Water Quality Data – Delete the row with the SO4

Parameter.

b. Table 1 – Add the following footnote: “TDS shall be calculated using the gravimetric analysis method.”

c. Paragraph A. Add the following as subparagraph 3:
“Maximum feed pressure shall be no greater than 140 psi when operating with 35 psig of permeate backpressure on stage 1 of the array and 15 psig of permeate backpressure on stage 2 of the array.”

1.6 DRAWINGS

A. Sheet G-04
1. In the “General Provisions” Add the following note as number 11: “CUTTING OF TREES 3” OR LARGER IN DIAMETER IS PERMITTED ONLY BETWEEN OCTOBER 1 AND MARCH 31.”
2. This sheet is not being Reissued as part of this Addendum.

B. Sheet C-13
1. In the concrete lined detail replace “CHANNEL DEPTH VARES” in the dimension with “ 6””.
2. This sheet is not being Reissued as part of this Addendum.

C. Sheet GP-03
1. Remove the following note “ALL CHEMICALS AND MATERIALS COMING INTO CONTACT WITH DRINKING WATER WILL HAVE NSF 60/61 CERTIFICATION.”
2. This sheet is not being Reissued as part of this Addendum.

D. Sheet GP-04
1. Revise “FS-2002” to read “FIT-2002”.
2. This sheet is not being Reissued as part of this Addendum.

E. Sheet GP-12
1. Revise “FS 2002” to read “FIT 2002”.
2. This sheet is not being Reissued as part of this Addendum.

F. Sheet PD-03
1. This sheet is being revised and Reissued as part of this Addendum.

G. Sheet A-06
1. Section E. Revise “C5X ALL AROUND” to read “C5X ALL AROUND (EXCEPT BOTTOM”. Add a chambered edge to the 4” Split-Face CMU Sill.
2. This sheet is not being Reissued as part of this Addendum.

H. Sheet A-15
1. Revise Signage Note 1 to read: “Final signage wording and final quantity of all signs to be determined during construction. Contractor shall include the following quantities of signs in their bid: Type A-1 (18), Type B-1 (4), Type C-1 (5), Type C-2 (8), Type D-1 (7), Type E-1 (6), Type F-1 (5), Type G-1 (3), Type H-1 (13), Type I-1 (1), Type J-1 (7), Type K-1 (12), and Type L-1 (6).
2. This sheet is not being Reissued as part of this Addendum.

I. Sheet S-01
   1. ADD A NEW LINE TO GENERAL NOTE 9, DESIGN LOADS, TO READ: 8" PRECAST PLANK WITH 2" GROUT TOPPING….....50 PSF (INCLUDES COLLATERAL LL = 10 PSF).
   2. This sheet is not being Reissued as part of this Addendum.

J. Sheet S-03
   1. This sheet is being revised and Reissued as an attachment to this addendum.

K. Sheet S-18
   1. This sheet is being revised and Reissued as an attachment to this addendum.

L. Sheet MP-01
   1. This sheet is being revised and Reissued as an attachment to this addendum.

M. Sheet MP-06
   1. This sheet is being revised and Reissued as an attachment to this addendum.

N. Sheet E-07
   1. This sheet is being revised and Reissued as an attachment to this addendum.

O. Sheet E-08
   1. Add the following text to the end of Drawing Note E:
      a. "SECURITY SYSTEM WILL GENERALLY INCLUDE A DOOR CONTACT FOR EACH EXTERIOR DOOR AND CARD READERS FOR ENTRY AND EXIT OF THE CONTROL ROOM."
   2. This sheet is not being Reissued as part of this Addendum.

P. Sheet E-09
   1. Add the following text to the end of Drawing Note C:
      a. "SECURITY SYSTEM WILL GENERALLY INCLUDE A DOOR CONTACT FOR EACH EXTERIOR DOOR AND CARD READERS FOR ENTRY AND EXIT OF THE CONTROL ROOM."
   2. This sheet is not being Reissued as part of this Addendum.

Q. Sheet E-17
   1. A dd the following circuit information to the Panelboard NF-DP1 Schedule:
      a. Use CKT-37/39/41 for the PROCESS ROOM OVERHEAD DOOR. Provide a 15A3P breaker.
      b. Use CKT-38/40/42 for the ANTISCALANT FEED ROOM OVERHEAD DOOR. Provide a 15A3P breaker.
      c. This sheet is not being Reissued as part of this Addendum.

R. Sheet E-33
   1. Add two rows to the schedule between Conduits P151 and P200. Add the following text across columns from left to right:
      a. "P, 152, 3/4", (3)#12+(1)#12G, PANELBOARD NF-DP1, PROCESS ROOM OVERHEAD DOOR, (blank)"
      b. "P, 153, 3/4", (3)#12+(1)#12G, PANELBOARD NF-DP1, ANTISCALANT FEED ROOM OVERHEAD DOOR, (blank)"
      c. This sheet is not being Reissued as part of this Addendum.

S. Sheet I-01
   1. For High Service Building PLC, add Coded Note 7 adjacent to EXISTING I/O MODULES.
   2. Under Coded Note 6, add Coded Note 7 text that reads, "ADD A NEW RTD MODULE TO THE EXISTING PLC RACK. PROVIDE ALL ASSOCIATED WIRING, TERMINAL BLOCKS, AND APPERTENANCES. RTD MODULE SHALL BE 1769-IR6 BY ALLEN-BRADLEY."
   3. This sheet is not being Reissued as part of this Addendum.

T. Sheet I-04
   1. For Detail 4, change Coded Note 2 to be Coded Note 3.
   2. Under Coded Note 2, add Coded Note 3 text that reads, "PROVIDE SIMILAR PANEL FOR SODIUM HYPOCHLORITE CHEMICAL SYSTEM TO THE LAYOUT SHOWN PER THIS DETAIL. SODIUM HYPOCHLORITE PANEL SHALL INCLUDE STORAGE TANK 3 DEVICES/CONTROLS."
   3. This sheet is not being Reissued as part of this Addendum.

END OF ADDENDUM NO. 4
(SEE ENCLOSURES)

THIS SECTION WAS REVISED AS PART OF ADD #3 & ADD #4
IT IS BEING REISSUED AS PART OF ADD #4

SECTION 00 4333

PROPOSED PRODUCTS FORM

PART 1 GENERAL

A. Bidder must complete this sheet for the listed items.

B. Circle the Manufacturer that bidder is proposing.

C. If the manufacturer for an item is not circled; or if more than one manufacturer is circled; the first manufacturer listed (from left to right) will be the declared manufacturer.

D. See the Instructions to Bidders for additional information.

LIST OF PROPOSED MANUFACTURERS

ADD #3 & ADD #4

Item		Declared Manufacturer
Motor Control Centers (Section 26 2419)		Allen-Bradley; Cutler-Hammer; ~~**Square D**~~
Variable Frequency Drives (Section 26 2923)		Allen-Bradley; Eaton
Vertical Turbine Pumps and Appurtenances (Section 43 2100.02)		Floway; Flowserve; Peerless**; Fairbanks-Morse**
Horizontal End Suction Pumps (Section 43 2100.23)		Flowserve; Sulzer**; Peerless**
Forced Draft Degasifier Towers (Section 43 3225)		DeLoach Indistries, Inc.; Tonka Equipment Co.
Chemical Peristaltic Metering Pumps and Appurtenances (Section 46 3344)		Watson Marlow Qdos
Polyethylene Chemical Storage Tanks and Appurtenances (Section 46 3393.01)		Flat Bottom: Poly Processing Conical Bottom: Snyder Industries
Cartridge Filters (Section 46 6320)		Fil-Trek; ~~**Nowata;**~~ Parker Hannafin**; Piedmont**

END OF SECTION 00 4333

THIS SECTION WAS REVISED AS PART OF ADD #3 & ADD #4
IT IS BEING REISSUED AS PART OF ADD #4

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THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #4

SECTION 00 5215

AGREEMENT BETWEEN OWNER AND CONTRACTOR

THIS AGREEMENT made this _____ day of _____ , 20_____ with the Warren County Board of Commissioners, 406 Justice Drive, Lebanon, Ohio, hereinafter called "OWNER" and _____, doing business as (an individual, a partnership, or a corporation) called "CONTRACTOR".

WITNESSETH: That for and in consideration of the payments and agreements hereinafter mentioned, to be performed by the Owner, the Contractor herby agrees with the Owner to commence and complete the construction described as follows:

RARWTP MEMBRANE SOFTENING UPGRADES

hereinafter called the project, for the sum of $ *(Contractors Bid Price)* and all work in connection therewith, under the terms as stated in the Conditions of the Contract; and as his (its or their) own proper cost and expense furnish all the materials, supplies, machinery, equipment, tools, superintendence, labor insurance, and other accessories and services necessary to complete the said project in accordance with the conditions and prices stated in the Proposal, Conditions of the Contract, the Specifications, and Contract Documents. "Contract Documents" means the following:

(A) ADVERTISEMENT FOR BIDS
(B) INSTRUCTIONS TO BIDDERS
(C) BID
(D) BID SECURITY
(E) AGREEMENT
(F) GENERAL CONDITIONS
(G) SUPPLEMENTARY CONDITIONS
(H) CONTRACT BOND (PERFORMANCE AND PAYMENT BONDS)
(I) NOTICE OF AWARD
(J) NOTICE TO PROCEED
(K) CHANGE ORDER
(L) DRAWINGS prepared or issued by AECOM.
(M) SPECIFICATIONS prepared or issued by AECOM.
(N) ADDENDUM

ADD #4

CONTRACTOR hereby agrees to commence work under this contract on or before a date to be specified in the NOTICE TO PROCEED of the OWNER and shall substantially complete the Contract Work within ~~**five hundred forty-eight (548)**~~ **seven hundred (700)** calendar days and fully complete the Contract Work in its entirety within ~~**six hundred forty (640)**~~ **seven hundred sixty (760)** calendar days after the date of the NOTICE TO PROCEED unless the period for completion is extended otherwise by the CONRACT DOCUMENTS.

CONTRACTOR also agrees to pay as liquidated damages, the amounts as stated in the

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #4

SUPPLEMENTARY GENERAL CONDITIONS.

This Agreement may be terminated by either party upon written notice in the event of substantial failure by the other party to perform in accordance with the terms of this Agreement. The nonperforming party shall have fifteen calendar days from the date of the termination notice to cure or to submit a plan for cure acceptable to the other party.

OWNER may terminate or suspend performance of this Agreement for OWNER'S convenience upon written notice to the CONTRACTOR. CONTRACTOR shall terminate or suspend performance of the services/work on a schedule acceptable to the OWNER.

The CONTRACTOR will indemnify and save the OWNER, their officers and employees, harmless from loss, expenses, costs, reasonable attorney's fees, litigation expenses, suits at law or in equity, causes of action, actions, damages, and obligations arising from (a) negligent, reckless or willful and wanton acts, errors or omissions by CONTRACTOR, its agents, employees, licensees, consultants, or subconsultants; (b) the failure of the CONTRACTOR, its agents, employees, licensees, consultants or subconsultants to observe the applicable standard of care in providing services pursuant to this agreement; (c) the intentional misconduct of the CONTRACTOR, its agents, employees, licensees, consultants, or subconsultants that result in injury to persons or damage to property for which the OWNER may be held legally liable.

The CONTRACTOR does hereby agree to indemnify and hold the OWNER harmless for any and all sums for which the OWNER may be required to pay or for which the OWNER may be held responsible for failure of the CONTRACTOR or any subcontractors to pay the prevailing wage upon this project.

The OWNER agrees to pay the CONTRACTOR in the manner and at such times as set forth in the General Provisions such amounts as required by the Contract Documents.

This Agreement shall be construed under the laws of the State of Ohio, and the parties hereby stipulate to the venue for any and all claims, disputes, interpretations, litigation of any kind arising out of this Agreement being exclusively in the Warren County, Ohio Court of Common Pleas (unless both parties mutually agree in writing to alternate dispute resolution), as well as waiving any right to bring or remove such matters in or to any other state or federal court.

This Agreement shall be binding upon all parties hereto and their respective heirs, executors, administrators, successors, and assigns.

CONTRACTOR shall bind every subcontractor to, and every subcontractor must agree to be bound by the terms of, this Agreement, as far as applicable to the subcontractor's work particularly pertaining to Prevailing Wages and EEO requirements. Nothing contained in this Agreement shall create any contractual relationship between any subcontractor and Owner, nor create any obligations on the part of the Owner to pay or see to the payment of any sums to any subcontractor.

IN WITNESS WHEREOF, the parties hereto have executed, or caused to be executed by their duly authorized officials, this Agreement in three (3) counterparts, each of which shall be deemed an original on the date first above written.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #4

Warren County Board of Commissioners
Owner

ATTEST:

By: _____

Name: _____
(Print)

Title: _____

By: _____

Name: _____
(Print)

Title: _____

By: _____

Name: _____
(Print)

Title: _____

By: _____

Name: _____
(Print)

Title: _____

APPROVED AS TO FORM:

By: _____

Name: _____
(Print)

Title: _____

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #4

CONTRACTOR:

_____

_____

_____

ATTEST: _____

By: _____ By: _____

Name _____ Name: _____
Print (Print)

Title: _____ Title: _____

END OF SECTION 00 5215

THIS SECTION IS BEING REVISED AND REIUSSED AS PART OF ADD #4

SECTION 00 7343

WAGE RATE REQUIREMENTS

PART 1 GENERAL

1.1 REFERENCE

A. Prevailing wage rates, as determined by the United States Department of Labor for Warren County, the county in which the project is located, shall be used in accordance with the provisions of the Davis-Bacon Wage determinations as provided in 29 CFR 1.5 and 1.6(b). A copy of these rates is attached.

1.2 USE

A. Keep posted at all times throughout the Contract period the wage rate pages that are effective at the time of Bid opening.

B. Maintain, throughout the construction period, a legible up-to-date copy. Post in a conspicuous place accessible to workers and protected from the weather.

C. The successful Bidder shall be required to conform to all provisions of the Federal Davis-Bacon and Related Acts (The Act) which requires that all laborers and mechanics employed by contractors and subcontractors performing on federal contracts (and contractors and subcontractors performing on federally assisted contracts under the related ACTS) in excess of $2,000 pay their laborers and mechanics not less than the prevailing wage rates and fringe benefits, as determined by the Secretary of Labor, for corresponding classes of laborers and mechanics employed on similar projects in the area.

D. All Bidders must abide by the latest prevailing wage rate listing effective at the time of Bid opening.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 7343

THIS SECTION IS BEING REVISED AND REIUSSED AS PART OF ADD #4

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"General Decision Number: OH20200001 05/01/2020

Superseded General Decision Number: OH20190001

State: Ohio

Construction Types: Heavy and Highway

Counties: Ohio Statewide.

Heavy and Highway Construction Projects

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate,if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	01/24/2020
2	02/07/2020
3	03/13/2020
4	03/20/2020
5	04/10/2020
6	05/01/2020

BROH0001-001 06/01/2019

DEFIANCE, FULTON (Excluding Fulton, Amboy & Swan Creek

Townships), HENRY (Excluding Monroe, Bartlow, Liberty, Washington, Richfield, Marion, Damascus & Townships & that part of Harrison Township outside corporate limits of city of Napoleon), PAULDING, PUTNAM and WILLIAMS COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0001-004 06/01/2019

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 29.34	16.11

BROH0003-002 06/01/2019

FULTON (Townships of Amboy, Swan Creek & Fulton), HENRY (Townships of Washington, Damascus, Richfield, Bartlow, Liberty, Harrison, Monroe, & Marion), LUCAS and WOOD (Townships of Perrysburg, Ross, Lake, Troy, Freedom, Montgomery, Webster, Center, Portage, Middleton, Plain, Liberty, Henry, Washington, Weston, Milton, Jackson & Grand Rapids) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0005-003 05/01/2019

CUYAHOGA, LORAIN & MEDINA (Hinckley, Granger, Brunswick, Liverpool, Montville, York, Homer, Harrisville, Chatham, Litchfield & Spencer Townships and the city of Medina)

	Rates	Fringes
BRICKLAYER		
BRICKLAYERS; CAULKERS; CLEANERS; POINTERS; & STONEMASONS	$ 34.85	16.94
SANDBLASTERS	$ 35.10	16.94
SEWER BRICKLAYERS & STACK BUILDERS	$ 35.35	16.94
SWING SCAFFOLDS	$ 35.35	16.94

BROH0006-005 06/01/2019

CARROLL, COLUMBIANA (Knox, Butler, West & Hanover Townships), STARK & TUSCARAWAS

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0007-002 06/01/2019

LAWRENCE

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0007-005 06/01/2019

PORTAGE & SUMMIT

	Rates	Fringes
BRICKLAYER	$ 29.34	16.11

BROH0007-010 06/01/2019

PORTAGE & SUMMIT

	Rates	Fringes
MASON - STONE	$ 29.34	16.11

BROH0008-001 06/01/2019

COLUMBIANA (Salem, Perry, Fairfield, Center, Elk Run, Middleton, & Unity Townships and the city of New Waterford), MAHONING & TRUMBULL

	Rates	Fringes
BRICKLAYER	$ 29.34	16.11

BROH0009-002 06/01/2019

BELMONT & MONROE COUNTIES and the Townships of Warren & Mt. Pleasant and the Village of Dillonvale in JEFFERSON COUNTY

	Rates	Fringes

Bricklayer, Stonemason	$ 29.34	16.11
Refractory	$ 31.45	19.01

BROH0010-002 06/01/2019

COLUMBIANA (St. Clair, Madison, Wayne, Franklin, Washington, Yellow Creek & Liverpool Townships) & JEFFERSON (Brush Creek & Saline Townships)

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0014-002 06/01/2019

HARRISON & JEFFERSON (Except Mt. Pleasant, Warren, Brush Creek, Saline & Salineville Townships & the Village of Dillonvale)

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0016-002 06/01/2019

ASHTABULA, GEAUGA, and LAKE COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0018-002 06/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON, PREBLE (Gasper, Dixon, Israel, Lanier, Somers & Gratis Townships) & WARREN COUNTIES:

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0022-004 06/01/2019

CHAMPAIGN, CLARK, CLINTON, DARKE, GREENE, HIGHLAND, LOGAN, MIAMI, MONTGOMERY, PREBLE (Jackson, Monroe, Harrison, Twin, Jefferson & Washington Townships) and SHELBY COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0032-001 06/01/2019

GALLIA & MEIGS

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0035-002 06/01/2019

ALLEN, AUGLAIZE, MERCER and VAN WERT COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0039-002 06/01/2019

ADAMS & SCIOTO

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0040-003 06/01/2019

ASHLAND, CRAWFORD, HARDIN, HOLMES, MARION, MORROW, RICHLAND, WAYNE and WYANDOT (Except Crawford, Ridge, Richland & Tymochtee Townships) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

FOOTNOTE: Layout Man and Sawman rate: $1.00 per hour above journeyman rate.
Free standing stack work ground level to top of stack; Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: $1.50 per hour above journeyman rate.
""Hot"" work: $2.50 above journeyman rate.

BROH0044-002 06/01/2019

	Rates	Fringes
Bricklayer, Stonemason COSHOCTON, FAIRFIELD, GUERNSEY, HOCKING, KNOX, KICKING, MORGAN, MUSKINGUM, NOBLE (Beaver, Buffalo, Seneca & Wayne Townships) & PERRY COUNTIES:	$ 29.34	16.11

BROH0045-002 06/01/2017

FAYETTE, JACKSON, PIKE, ROSS and VINTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 28.65	14.55

BROH0046-002 06/01/2019

ERIE, HANCOCK, HURON, OTTAWA, SANDUSKY, SENECA, WOOD (Perry & Bloom Townships) and WYANDOT (Tymochtee, Crawford, Ridge & Richland Townships) COUNTIES & the Islands of Lake Erie north of Sandusky

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

FOOTNOTE: Layout Man and Sawman rate: $1.00 per hour above journeyman rate.
Free standing stack work ground level to top of stack; Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: $1.50 per hour above journeyman rate.
""Hot"" work: $2.50 above journeyman rate.

BROH0052-001 06/01/2019

ATHENS COUNTY

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0052-003 06/01/2019

NOBLE (Brookfield, Noble, Center, Sharon, Olive, Enoch, Stock, Jackson, Jefferson & Elk Townships) and WASHINGTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0055-003 06/01/2017

DELAWARE, FRANKLIN, MADISON, PICKAWAY and UNION COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 28.65	14.55

CARP0003-004 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
CARPENTER	$ 26.20	17.42

CARP0069-003 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
CARPENTER	$ 25.98	15.98

CARP0069-006 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
CARPENTER	$ 24.04	15.29

CARP0171-002 05/01/2019

BELMONT, COLUMBIANA, HARRISON, JEFFERSON & MONROE

	Rates	Fringes
CARPENTER	$ 27.37	20.02

CARP0200-002 05/01/2017

ADAMS, ATHENS, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GALLIA, GUERNSEY, HIGHLAND, HOCKING, JACKSON, LAWRENCE, LICKING, MADISON, MARION, MEIGS, MORGAN, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE, ROSS, SCIOTO, UNION, VINTON and WASHINGTON COUNTIES

	Rates	Fringes
CARPENTER	$ 29.07	16.22
Diver	$ 39.41	10.40
PILEDRIVERMAN	$ 29.07	16.22

CARP0248-005 07/01/2008

LUCAS & WOOD

	Rates	Fringes
CARPENTER	$ 27.27	14.58

CARP0248-008 07/01/2008

	Rates	Fringes
CARPENTER DEFIANCE, FULTON, HANCOCK, HENRY, PAULDING & WILLIAMS COUNTIES	$ 23.71	13.28

CARP0254-002 05/01/2017

ASHTABULA, CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
CARPENTER	$ 32.40	16.97

CARP0372-002 05/01/2016

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM & VAN WERT

	Rates	Fringes
CARPENTER	$ 24.54	18.21

CARP0639-003 05/01/2017

MEDINA, PORTAGE & SUMMIT

	Rates	Fringes
CARPENTER	$ 30.42	16.99

CARP0735-002 05/01/2019

ASHLAND, ERIE, HURON, LORAIN & RICHLAND

	Rates	Fringes
CARPENTER	$ 26.30	17.91

CARP1311-001 05/01/2017

BROWN, BUTLER, CHAMPAIGN, CLARK, CLERMONT, CLINTON, DARKE, GREENE, HAMILTON, LOGAN, MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN

	Rates	Fringes
Carpenter & Piledrivermen	$ 29.34	15.95
Diver	$ 40.58	9.69

CARP1393-002 07/01/2008

CRAWFORD, DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Piledrivermen & Diver's Tender...	$ 27.30	16.05

DIVERS - $250.00 per day

CARP1393-003 07/01/2008

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM, VAN WERT & WYANDOT

	Rates	Fringes
Piledrivermen & Diver's Tender...	$ 25.15	15.92

DIVERS - $250.00 per day

CARP1871-006 05/01/2017

BELMONT, HARRISON, & MONROE

	Rates	Fringes
Diver, Wet	$ 48.11	17.33
Piledrivermen; Diver, Dry	$ 32.07	17.33

CARP1871-008 05/01/2017

ASHLAND, ASHTABULA, CUYAHOGA, ERIE, GEAUGA, HURON, LAKE, LORAIN, MEDINA, PORTAGE, RICHLAND & SUMMIT

	Rates	Fringes
Diver, Wet	$ 45.80	18.84
Piledrivermen; Diver, Dry	$ 30.53	18.84

CARP1871-014 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
Diver, Wet	$ 38.34	16.95
Piledrivermen; Diver, Dry	$ 25.56	16.95

CARP1871-015 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
Diver, Wet	$ 37.34	16.07
Piledrivermen; Diver, Dry	$ 24.89	16.07

CARP1871-017 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
Diver, Wet	$ 40.65	17.62
Piledrivermen; Diver, Dry	$ 27.10	17.62

CARP2235-012 01/01/2014

COLUMBIANA & JEFFERSON

	Rates	Fringes
PILEDRIVERMAN	$ 31.74	16.41

CARP2239-001 07/01/2008

CRAWFORD, OTTAWA, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
CARPENTER	$ 23.71	13.28

ELEC0008-002 05/27/2019

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
CABLE SPLICER	$ 38.98	18.96
ELECTRICIAN	$ 40.45	1.5%+20.23

ELEC0032-003 12/02/2019

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Ridgeland, Ridge & Salem Townships)

	Rates	Fringes
ELECTRICIAN	$ 31.37	19.24

ELEC0038-002 04/29/2019

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
ELECTRICIAN		
Excluding Sound & Communications Work	$ 39.13	20.69

FOOTNOTES;
a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

ELEC0038-008 04/29/2019

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
Sound & Communication Technician		
Communications Technician...	$ 27.55	11.98
Installer Technician	$ 26.30	11.94

FOOTNOTES;
a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

ELEC0064-003 11/25/2019

COLUMBIANA (Butler, Fairfield, Perry, Salem & Unity Townships) MAHONING (Austintown, Beaver, Berlin, Boardman, Canfield, Ellsworth, Coitsville, Goshen, Green, Jackson, Poland, Springfield & Youngstown Townships), & TRUMBULL (Hubbard & Liberty Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.67	15.83

ELEC0071-001 01/01/2019

ASHLAND, CHAMPAIGN, CLARK, COSHOCTON, CRAWFORD, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GUERNSEY, HIGHLAND, HOCKING, JACKSON (Coal, Jackson, Liberty, Milton, Washington & Wellston Townships), KNOX, LICKING, MADISON, MARION, MONROE, MORGAN, MORROW, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, Peepee, Perry & Seal Townships), RICHLAND, ROSS, TUSCARAWAS (Auburn, Bucks, Clay, Jefferson, Oxford, Perry, Salem, Rush, Washington & York Townships), UNION, VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships), and WASHINGTON COUNTIES

	Rates	Fringes
Line Construction		

Equipment Operators.....$ 33.62 13.40
Groundmen.....$ 24.17 11.32
Linemen & Cable Splicers....$ 38.27 14.42

ELEC0071-004 01/01/2019

AUGLAIZE, CLINTON, DARKE, GREENE, LOGAN, MERCER, MIAMI, MONTGOMERY, PREBLE, and SHELBY COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-005 12/31/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE & LORAIN

	Rates	Fringes
LINE CONSTRUCTION: Equipment Operator		
DOT/Traffic Signal & Highway Lighting Projects	$ 32.44	14.10
Municipal Power/Transit Projects	$ 40.10	16.42
LINE CONSTRUCTION: Groundman		
DOT/Traffic Signal & Highway Lighting Projects	$ 25.06	12.26
Municipal Power/Transit Projects	$ 31.19	14.11
LINE CONSTRUCTION: Linemen/Cable Splicer		
DOT/Traffic Signal & Highway Lighting Projects	$ 36.13	15.03
Municipal Power/Transit Projects	$ 44.56	17.58

ELEC0071-008 01/01/2019

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32

Lineman & Cable Splicers....$ 38.27 14.42

ELEC0071-010 01/01/2019

BELMONT, CARROLL, HARRISON, HOLMES, JEFFERSON, MEDINA, PORTAGE, STARK, SUMMIT, and WAYNE COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-013 01/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON, and WARREN COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-014 01/01/2019

ADAMS, ATHENS, GALLIA, JACKSON (Bloomfield, Franklin, Hamilton, Lick, Jefferson, Scioto & Madison Townships), LAWRENCE, MEIGS, PIKE (Camp Creek, Marion, Newton, Scioto, Sunfish & Union Townships), SCIOTO & VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships)

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0082-002 12/02/2019

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes

ELECTRICIAN.....$ 31.15 19.96

ELEC0082-006 11/26/2018

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
Sound & Communication Technician		
Cable Puller	$ 12.18	3.85
Installer/Technician	$ 24.35	11.29

ELEC0129-003 03/25/2019

LORAIN (Except Columbia Township) & MEDINA (Litchfield & Liverpool Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.35	17.30

ELEC0129-004 03/25/2019

ERIE & HURON (Lyme, Ridgefield, Norwalk, Townsend, Wakeman, Sherman, Peru, Bronson, Hartland, Clarksfield, Norwich, Greenfield, Fairfield, Fitchville & New London Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.35	17.30

ELEC0141-003 09/01/2019

BELMONT COUNTY

	Rates	Fringes
CABLE SPLICER	$ 30.63	25.87
ELECTRICIAN	$ 30.38	25.87

ELEC0212-003 11/26/2018

BROWN, CLERMONT & HAMILTON

	Rates	Fringes

Sound & Communication Technician.....$ 24.35 10.99

ELEC0212-005 06/03/2019

BROWN, CLERMONT, and HAMILTON COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.18	18.89

ELEC0245-001 01/01/2020

ALLEN, HARDIN, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Richland, Ridge & Salem Townships)

	Rates	Fringes
Line Construction		
Equipment Operator	$ 32.37	25.9%+6.75
Groundman Truck Driver	$ 17.70	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75

FOOTNOTE: a. Half day's Paid Holiday: The last 4 hours of the workday prior to Christmas or New Year's Day

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ELEC0245-003 01/01/2020

DEFIANCE, FULTON, HANCOCK, HENRY, HURON, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS, and WOOD COUNTIES

	Rates	Fringes
Line Construction		
Cable Splicer	$ 46.53	25.9%+6.75
Groundman/Truck Driver	$ 17.70	25.9%+6.75
Heli-arc Welding	$ 40.76	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75
Operator - Class 1	$ 32.37	25.9%+6.75
Operator - Class 2	$ 28.32	25.9%+6.75
Traffic Signal & Lighting Technician	$ 36.41	25.9%+6.75

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be

paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

ELEC0245-004 01/01/2020

ERIE COUNTY

	Rates	Fringes
Line Construction		
Cable Splicer	$ 46.53	25.9%+6.75
Groundman/Truck Driver	$ 17.70	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75
Operator - Class 1	$ 32.37	25.9%+6.75
Operator - Class 2	$ 28.32	25.9%+6.75

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

ELEC0246-001 10/29/2018

	Rates	Fringes
ELECTRICIAN	$ 38.00	84%+a

FOOTNOTE: a. 1 1/2 Paid Holidays: The last scheduled workday prior to Christmas & 4 hours on Good Friday.

ELEC0306-005 05/28/2018

MEDINA (Brunswick, Chatham, Granger, Guilford, Harrisville, Hinckley, Homer, Lafayette, Medina, Montville, Sharon, Spencer, Wadsworth, Westfield & York Townships), PORTAGE (Atwater, Aurora, Brimfield, Deerfield, Franklin, Mantua, Randolph, Ravenna, Rootstown, Shalersville, Streetsboro & Suffield Townships), SUMMIT & WAYNE (Baughman, Canaan, Chester, Chippewa, Congress, Green, Milton, & Wayne Townships)

	Rates	Fringes
CABLE SPLICER	$ 36.87	16.56
ELECTRICIAN	$ 34.54	5%+18.06

ELEC0317-002 06/01/2019

GALLIA & LAWRENCE

	Rates	Fringes
CABLE SPLICER	$ 32.68	18.13
ELECTRICIAN	$ 34.35	25.70

ELEC0540-005 01/01/2020

CARROLL (Northern half, including Fox, Harrison, Rose & Washington Townhships), COLUMBIANA (Knox Township), HOLMES, MAHONING (Smith Township), STARK, TUSCARAWAS (North of Auburn, Clay, Rush & York Townships), and WAYNE (South of Baughman, Chester, Green & Wayne Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 33.71	24.22

ELEC0573-003 11/25/2019

ASHTABULA (Colebrook, Wayne, Williamsfield, Orwell & Windsor Townships), GEAUGA (Auburn, Middlefield, Parkman & Troy Townships), MAHONING (Milton Township), PORTAGE (Charlestown, Edinburg, Freedom, Hiram, Nelson, Palmyra, Paris & Windham Townships), and TRUMBULL (Except Liberty & Hubbard Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.21	19.24

ELEC0575-001 05/27/2019

ADAMS, FAYETTE, HIGHLAND, HOCKING, JACKSON (Bloomfield, Franklin, Hamilton, Jefferson, Lick, Madison, Scioto, Coal, Jackson, Liberty, Milton & Washington Townships), PICKAWAY (Deer Creek, Perry, Pickaway, Salt Creek & Wayne Townships), PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, PeePee, Perry, Seal, Camp Creek, Newton, Scioto, Sunfish, Union & Marion Townships), ROSS, SCIOTO & VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships)

	Rates	Fringes
ELECTRICIAN	$ 33.75	17.19

ELEC0648-001 09/02/2019

BUTLER and WARREN COUNTIES (Deerfield, Hamilton, Harlan, Massie, Salem, Turtle Creek, Union & Washington Townships)

	Rates	Fringes
CABLE SPLICER	$ 30.50	18.23
ELECTRICIAN	$ 30.00	19.85

ELEC0673-004 02/01/2020

ASHTABULA (Excluding Orwell, Colebrook, Williamsfield, Wayne & Windsor Townships), GEAUGA (Burton, Chardon, Claridon, Hambden, Huntsburg, Montville, Munson, Newbury & Thompson Townships) and LAKE COUNTIES

	Rates	Fringes
CABLE SPLICER	$ 33.81	21.47
ELECTRICIAN	$ 33.56	21.47

ELEC0683-002 05/27/2019

CHAMPAIGN, CLARK, DELAWARE, FAIRFIELD, FRANKLIN, MADISON, PICKAWAY (Circleville, Darby, Harrison, Jackson, Madison, Monroe, Muhlenberg, Scioto, Walnut & Washington Townships), and UNION COUNTIES

	Rates	Fringes
CABLE SPLICER	$ 34.50	21.20
ELECTRICIAN	$ 33.50	20.18

ELEC0688-003 12/02/2019

ASHLAND, CRAWFORD, HURON (Richmond, New Haven, Ripley & Greenwich Townships), KNOX (Liberty, Clinton, Union, Howard, Monroe, Middleberry, Morris, Wayne, Berlin, Pike, Brown & Jefferson Townships), MARION, MORROW, RICHLAND and WYANDOT (Sycamore, Crane, Eden, Pitt, Antrim & Tymochtee Townships) COUNTIES

	Rates	Fringes

ELECTRICIAN	$ 30.00	18.86

ELEC0972-002 06/01/2019

ATHENS, MEIGS, MONROE, MORGAN, NOBLE, VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships), and WASHINGTON COUNITES

	Rates	Fringes
CABLE SPLICER	$ 33.80	26.65
ELECTRICIAN	$ 33.55	26.65

ELEC1105-001 05/28/2018

COSHOCTON, GUERNSEY, KNOX (Jackson, Clay, Morgan, Miller, Milford, Hilliar, Butler, Harrison, Pleasant & College Townships), LICKING, MUSKINGUM, PERRY, and TUSCARAWAS (Auburn, York, Clay, Jefferson, Rush, Oxford, Washington, Salem, Perry & Bucks Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.95	17.96

ENGI0018-003 05/01/2019

ASHTABULA, CUYAHOGA, ERIE, GEAUGA, LAKE, LORAIN, MEDINA, PORTAGE, and SUMMIT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1	$ 38.63	15.20
GROUP 2	$ 38.53	15.20
GROUP 3	$ 37.49	15.20
GROUP 4	$ 36.27	15.20
GROUP 5	$ 30.98	15.20
GROUP 6	$ 38.88	15.20
GROUP 7	$ 39.13	15.20

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump;

Crane (All Types, Including Boom Truck, Cherry Picker); Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24"" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; Wheel Excavator; and Asphalt Plant Engineer (Cleveland District Only).

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48""; Bulldozer; Endloader; Horizontal Directional Drill (Over 50,000 ft lbs thrust); Hydro Milling Machine; Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24"" wide & under); Vermeer type Concrete Saw; and Maintenance Operators (Portage and Summit Counties Only).

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer (Portage and Summit Counties Only); Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4"" & over discharge); Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); Welding Machines; and Railroad Tie Inserter/Remover; Articulating/straight bed end dumps if

assigned (minus $4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48"" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Forklift; Form Trencher; Hydro Hammer expect masonary; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonry Fork Lift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4"" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0018-004 05/01/2019

ADAMS, ALLEN, ASHLAND, ATHENS, AUGLAIZE, BELMONT, BROWN, BUTLER, CARROLL, CHAMPAIGN, CLARK, CLERMONT, CLINTON, COSHOCTON, CRAWFORD, DARKE, DEFIANCE, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, FULTON, GALLIA, GREENE, GUERNSEY, HAMILTON, HANCOCK, HARDIN, HARRISON, HENRY, HIGHLAND, HOCKING, HOLMES, HURON, JACKSON, JEFFERSON, KNOX, LAWRENCE, LICKING, LOGAN, LUCAS, MADISON, MARION, MEIGS, MERCER, MIAMI, MONROE, MONTGOMERY, MORGAN, MORROW, MUSKINGUM, NOBLE, OTTAWA, PAULDING, PERRY, PICKAWAY, PIKE, PREBLE, PUTNAM, RICHLAND, ROSS, SANDUSKY, SCIOTO, SENECA, SHELBY, STARK, TUSCARAWAS, UNION, VAN WERT, VINTON, WARREN, WASHINGTON, WAYNE, WILLIAMS, WOOD, and YANDOT COUNTIES

	Rates	Fringes

POWER EQUIPMENT OPERATOR		
GROUP 1	$ 37.14	15.20
GROUP 2	$ 37.02	15.20
GROUP 3	$ 35.98	15.20
GROUP 4	$ 34.80	15.20
GROUP 5	$ 29.34	15.20
GROUP 6	$ 37.39	15.20
GROUP 7	$ 37.64	15.20

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker); Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24"" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; and Wheel Excavator.

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48""; Bulldozer; Endloader; Hydro Milling Machine; Horizontal Directional Drill (over 50,000 ft. lbs. thrust);Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24"" wide & under); and Vermeer type Concrete Saw.

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low

pressure); Asphalt Plant Engineer; Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4"" & over discharge); Railroad Tie Inserter/Remover; Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); and Welding Machines; Artiaculating/straight bed end dumps if assigned (minus $4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48"" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Fork Lift; Form Trencher; Hydro Hammer expect masonary; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonary Forklift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4"" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0066-023 06/01/2017

COLUMBIANA, MAHONING & TRUMBULL COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		

ASBESTOS; HAZARDOUS/TOXIC
WASTE PROJECTS

GROUP 1 - A & B.....$ 39.23 19.66
ASBESTOS; HAZARDOUS/TOXIC
WASTE PROJECTS

GROUP 2 - A & B.....$ 38.90 19.66
ASBESTOS; HAZARDOUS/TOXIC
WASTE PROJECTS

GROUP 3 - A & B.....$ 34.64 19.66
ASBESTOS; HAZARDOUS/TOXIC
WASTE PROJECTS

GROUP 4 - A & B.....$ 30.70 19.66
ASBESTOS; HAZARDOUS/TOXIC
WASTE PROJECTS

GROUP 5 - A & B.....$ 27.30 19.66
HAZARDOUS/TOXIC WASTE
PROJECTS

GROUP 1 - C & D.....$ 35.96 19.66
HAZARDOUS/TOXIC WASTE
PROJECTS

GROUP 2 - C & D.....$ 35.66 19.66
HAZARDOUS/TOXIC WASTE
PROJECTS

GROUP 3 - C & D.....$ 31.76 19.66
HAZARDOUS/TOXIC WASTE
PROJECTS

GROUP 4 - C & D.....$ 28.14 19.66
HAZARDOUS/TOXIC WASTE
PROJECTS

GROUP 5 - C & D.....$ 25.03 19.66
ALL OTHER WORK

GROUP 1.....$ 32.69 19.66
ALL OTHER WORK

GROUP 2.....$ 32.42 19.66
ALL OTHER WORK

GROUP 3.....$ 28.87 19.66
ALL OTHER WORK

GROUP 4.....$ 25.58 19.66
ALL OTHER WORK

GROUP 5.....$ 22.75 19.66

GROUP 1 - Rig, Pile Driver or Caisson Type; & Rig, Pile Hydraulic Unit Attached

GROUP 2 - Asphalt Heater Planer; Backfiller with Drag Attachment; Backhoe; Backhoe with Shear attached; Backhoe-Rear Pivotal Swing; Batch Plant-Central Mix Concrete; Batch Plant, Portable concrete; Berm Builder-Automatic; Boat Derrick; Boat-Tug; Boring Machine Attached to Tractor; Bullclam; Bulldozer; C.M.I. Road Builder & Similar Type; Cable Placer & Layer; Carrier-Straddle; Carryall-Scraper or Scoop; Chicago Boom; Compactor with Blade Attached; Concrete Saw (Vermeer or similar type); Concrete Spreader Finisher; Combination, Bidwell Machine; Crane; Crane-Electric Overhead; Crane-Rough Terrain; Crane-Side Boom; Crane-Truck; Crane-Tower; Derrick-Boom; Derrick-Car; Digger-Wheel (Not trencher or road widener); Double Nine; Drag Line; Dredge; Drill-Kenny or Similar Type; Easy Pour Median Barrier Machine (or similar type); Electromatic; Frankie Pile; Gradall; Grader; Gurry; Self-Propelled; Heavy Equipment Robotics Operator/Mechanic; Hoist-Monorail; Hoist-Stationary & Mobile Tractor; Hoist, 2 or 3 drum; Horizontal Directional Drill Operator; Jackall; Jumbo Machine; Kocal & Kuhlman; Land-Seagoing Vehicle; Loader, Elevating; Loader, Front End; Loader, Skid Steer; Locomotive; Mechanic/Welder; Metro Chip Harvester with Boom; Mucking Machine; Paver-Asphalt Finishing Machine; Paver-Road Concrete; Paver-Slip Form (C.M.I. or similar); Place Crete Machine with Boom; Post Driver (Carrier mounted); Power Driven Hydraulic Pump & Jack (When used in Slip Form or Lift Slab Construction); Pump Crete Machine; Regulator-Ballast; Hydraulic Power Unit not attached to Rig for Pile Drillings; Rigs-Drilling; Roto Mill or similar Full Lane (8' Wide & Over); Roto Mill or similar type (Under 8'); Shovel; Slip Form Curb Machine; Speedwing; Spikemaster; Stonecrusher; Tie Puller & Loader; Tie Tamper; Tractor-Double Boom; Tractor with Attachments; Truck-Boom; Truck-Tire; Trench Machine; Tunnel Machine (Mark 21 Java or similar); & Whirley (or similar type)

GROUP 3 - Asphalt Plant; Bending Machine (Pipeline or similar type); Boring machine, Motor Driven; Chip Harvester without Boom; Cleaning Machine, Pipeline Type; Coating Machine, Pipeline Type; Compactor; Concrete Belt Placer;

Concrete Finisher; Concrete Planer or Asphalt; Concrete Spreader; Elevator; Fork Lift (Home building only); Fork lift & Lulls; Fork Lift Walk Behind (Hoisting over 1 buck high); Form Line Machine; Grease Truck operator; Grout Pump; Gunnite Machine; Horizontal Directional Drill Locator; Single Drum Hoist with or without Tower; Huck Bolting Machine; Hydraulic Scaffold (Hoisting building materials); Paving Breaker (Self-propelled or Ridden); Pipe Dream; Pot Fireperson (Power Agitated); Refrigeration Plant; Road Widener; Roller; Sasgen Derrick; Seeding Machine; Soil Stabilizer (Pump type); Spray Cure Machine, Self-Propelled; Straw Blower Machine; Sub-Grader; Tube Finisher or Broom C.M.I. or similar type; & Tugger Hoist

GROUP 4 - Air Curtain Destructor & Similar Type; Batch Plant-Job Related; Boiler Operator; Compressor; Conveyor; Curb Builder, self-propelled; Drill Wagon; Generator Set; Generator-Steam; Heater-Portable Power; Hydraulic Manipulator Crane; Jack-Hydraulic Power driven; Jack-Hydraulic (Railroad); Ladavator; Minor Machine Operator; Mixer-Concrete; Mulching Machine; Pin Puller; Power Broom; Pulverizer; Pump; Road Finishing Machine (Pull Type); Saw-Concrete-Self-Propelled (Highway Work); Signal Person; Spray Cure Machine-Motor Powered; Stump Cutter; Tractor; Trencher Form; Water Blaster; Steam Jenny; Syphon; Vibrator-Gasoline; & Welding Machine

GROUP 5 - Brakeperson; Fireperson; & Oiler

IRON0017-002 05/01/2019

ASHTABULA (North of Route 6, starting at the Geauga County Line, proceeding east to State Route 45), CUYAHOGA, ERIE (Eastern 2/3), GEAUGA, HURON (East of a line drawn from the north border through Monroeville & Willard), LAKE, LORAIN, MEDINA (North of Old Rte. #224), PORTAGE (West of a line from Middlefield to Shalersville to Deerfield), and SUMMIT (North of Old Rte. #224, including city limits of Barberton) COUNTIES

	Rates	Fringes
IRONWORKER		
Ornamental, Reinforcing, & Structural	$ 34.93	22.00

IRON0017-010 05/01/2019

ASHTABULA (Eastern part from Lake Erie on the north to route

#322 on the south to include Conneaut, Kingsville, Sheffield, Denmark, Dorset, Cherry Valley, Wayne, Monroe, Pierpont, Richmond, Andover & Williamsfield Townships)

	Rates	Fringes
IRONWORKER		
Structural, including metal building erection & Reinforcing	$ 34.93	22.00

IRON0044-001 06/01/2018

ADAMS (Western Part), BROWN, BUTLER (Southern Part), CLERMONT, CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) and WARREN (South of a line drawn from Blanchester through Morrow to the west county line) COUNTIES

	Rates	Fringes
IRONWORKER, REINFORCING		
Beyond 30-mile radius of Hamilton County Courthouse	$ 28.67	21.20
Up to & including 30-mile radius of Hamilton County Courthouse	$ 27.60	20.70

IRON0044-002 06/01/2019

CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) & WARREN (South of a line drawn from Blanchester through Morrow to the west county line)

	Rates	Fringes
IRONWORKER		
Fence Erector	$ 28.00	21.20
Ornamental; Structural	$ 29.47	21.20

IRON0055-003 07/01/2019

CRAWFORD (Area Between lines drawn from where Hwy #598 & #30 meet through N. Liberty to the northern border & from said Hwy junction point due west to the border), DEFIANCE (S. of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), ERIE (Western 1/3), FULTON, HANCOCK, HARDIN (North of a line drawn from Maysville to a point 4 miles south of the northern line on the eastern line), HENRY, HURON (West of a line drawn from the northern border through Monroeville & Willard), LUCAS, OTTAWA, PUTNAM (East of a line drawn from the northern border down through Miller City to where #696 meets the southern border), SANDUSKY, SENECA, WILLIAMS (East of a line drawn from Pioneer through Stryker to the southern border), WOOD & WYANDOT (North of Rte. #30)

	Rates	Fringes
IRONWORKER		
Fence Erector	$ 21.30	20.92
Flat Road Mesh	$ 29.77	21.30
Tunnels & Caissons Under Pressure	$ 29.77	21.30
All Other Work	$ 30.38	24.40

IRON0147-002 06/01/2015

ALLEN (Northern half), DEFIANCE (Northern part, excluding south of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), MERCER (Northern half), PAULDING, PUTNAM (Western part, excluding east of a line drawn from the northern border down through Miller City to where #696 meets the southern border), VAN WERT, and WILLIAMS (Western part, excluding east of a line drawn from Pioneer through Stryker to the southern border) COUNTIES

	Rates	Fringes
IRONWORKER	$ 25.39	20.64

IRON0172-002 06/01/2019

CHAMPAIGN (Eastern one-third), CLARK (Eastern one-fourth), COSHOCTON (West of a line beginning at the northwestern county line going through Walhonding & Tunnel Hill to the southern county line), CRAWFORD (South of Rte. #30), DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, HARDIN (Excluding a line drawn from Roundhead to Maysville), HIGHLAND (Eastern one-fifth), HOCKING, JACKSON (Northern half), KNOX, LICKING, LOGAN (Eastern

one-third), MADISON, MARION, MORROW, MUSKINGUM (West of a line starting at Adams Mill going to Adamsville & going from Adamsville through Blue Rock to the southern border), PERRY, PICKAWAY, PIKE (Northern half), ROSS, UNION, VINTON and WYANDOT (South of Rte. #30) COUNTIES

	Rates	Fringes
IRONWORKER	$ 30.00	20.70

IRON0207-004 06/01/2019

ASHTABULA (Southern part starting at the Geauga County line), COLUMBIANA (E. of a line from Damascus to Highlandtown), MAHONING (N. of Old Route #224), PORTAGE (E. of a line from Middlefield to Shalersville to Deerfield) & TRUMBULL

	Rates	Fringes
IRONWORKER		
Layout; Sheeter	$ 30.72	25.15
Ornamental; Reinforcing; Structural	$ 28.06	24.70
Ornamental; Reinforcing	$ 29.72	25.18

IRON0290-002 06/01/2019

ALLEN (Southern half), AUGLAIZE, BUTLER (North of a line drawn from east to the west county line going through Oxford, Darrtown & Woodsdale), CHAMPAIGN (Excluding east of a line drawn from Catawla to the point where #68 intersects the northern county line), CLARK (Western two-thirds), CLINTON (Excluding south of a line drawn from Blanchester to Lynchburg), DARKE, GREENE, HIGHLAND (Inside lines drawn from Marshall to Lynchburg & from the northern county line through East Monroe to Marshall), LOGAN (West of a line drawn from West Liberty to where the northern county line meets the western county line of Hardin), MERCER (Southern half), MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN (Excluding south of a line drawn from Blanchester through Morrow to the western county line) COUNTIES

	Rates	Fringes
IRONWORKER	$ 29.23	33.35

IRON0549-003 12/01/2018

BELMONT, GUERNSEY, HARRISON, JEFFERSON, MONROE & MUSKINGUM (Excluding portion west of a line starting at Adams Mill going to Adamsville and going from Adamsville through Blue Rock to the south border)

	Rates	Fringes
IRONWORKER	$ 33.34	20.81

IRON0550-004 05/01/2019

ASHLAND, CARROLL, COLUMBIANA (W. of a line from Damascus to Highlandtown), COSHOCTON (E. of a line beginning at NW Co. line going through Walhonding & Tunnel Hill to the South Co. line), HOLMES, HURON (S. of Old Rte. #224), MAHONING (S. of Old Rte. #224), MEDINA (S. of Old Rte. #224), PORTAGE (S. of Old Rte. #224), RICHLAND, STARK, SUMMIT (S. of Old Rte. #224, Excluding city limits of Barberton), TUSCARAWAS, & WAYNE

	Rates	Fringes
Ironworkers:Structural, Ornamental and Reinforcing	$ 28.90	19.87

IRON0769-004 06/01/2019

ADAMS (Eastern Half), GALLIA, JACKSON (Southern Half), LAWRENCE & SCIOTO

	Rates	Fringes
IRONWORKER	$ 32.00	25.95

IRON0787-003 12/01/2019

ATHENS, MEIGS, MORGAN, NOBLE, and WASHINGTON COUNTIES

	Rates	Fringes
IRONWORKER	$ 30.18	22.75

LABO0265-008 05/01/2018

	Rates	Fringes
LABORER		

ASHTABULA, ERIE, HURON, LORAIN, LUCAS, MAHONING, MEDINA, OTTAWA, PORTAGE, SANDUSKY, STARK, SUMMIT, TRUMBULL & WOOD COUNTIES		
GROUP 1	$ 31.05	10.95
GROUP 2	$ 31.22	10.95
GROUP 3	$ 31.55	10.95
GROUP 4	$ 32.00	10.95
CUYAHOGA AND GEAUGA COUNTIES ONLY: SEWAGE PLANTS, WASTE PLANTS, WATER TREATMENT FACILITIES, PUMPING STATIONS, & ETHANOL PLANTS CONSTRUCTION	$ 33.66	10.95
CUYAHOGA, GEAUGA & LAKE COUNTIES		
GROUP 1	$ 32.28	10.95
GROUP 2	$ 32.45	10.95
GROUP 3	$ 32.78	10.95
GROUP 4	$ 33.23	10.95
REMAINING COUNTIES OF OHIO		
GROUP 1	$ 30.62	10.95
GROUP 2	$ 30.79	10.95
GROUP 3	$ 31.12	10.95
GROUP 4	$ 31.57	10.95

LABORER CLASSIFICATIONS

GROUP 1 - Asphalt Laborer; Carpenter Tender; Concrete Curing Applicator; Dump Man (Batch Truck); Guardrail and Fence Installer; Joint Setter; Laborer (Construction); Landscape Laborer; Mesh Handlers & Placer; Right-of-way Laborer; Riprap Laborer & Grouter; Scaffold Erector; Seal Coating; Surface Treatment or Road Mix Laborer; Sign Installer; Slurry Seal; Utility Man; Bridge Man; Handyman; Waterproofing Laborer; Flagperson; Hazardous Waste (level D); Diver Tender; Zone Person & Traffic Control

GROUP 2 - Asphalt Raker; Concrete Puddler; Kettle Man Pipeline); Machine Driven Tools (Gas, Electric, Air); Mason Tender; Brick Paver; Mortar Mixer; Power Buggy or Power Wheelbarrow; Paint Striper; Sheeting & Shoring Man; Surface Grinder Man; Plastic Fusing Machine Operator; Pug Mill Operator; & Vacuum Devices (wet or dry); Rodding Machine Operator; Diver; Screwman or Paver; Screed Person; Water Blast, Hand Held Wand; Pumps 4"" & Under (Gas, Air or Electric) & Hazardous Waste (level C); Air Track and Wagon Drill; Bottom Person; Cofferdam (below 25 ft. deep);

Concrete Saw Person; Cutting with Burning Torch; Form Setter; Hand Spiker (Railroad); Pipelayer; Tunnel Laborer (without air) & Caisson; Underground Person (working in Sewer and Waterline, Cleaning, Repairing & Reconditioning); Sandblaster Nozzle Person; & Hazardous Waste (level B)

GROUP 3 - Blaster; Mucker; Powder Person; Top Lander; Wrencher (Mechanical Joints & Utility Pipeline); Yarner; Hazardous Waste (level A); Concrete Specialist; Concrete Crew in Tunnels (With Air-pressurized - $1.00 premium); Curb Setter & Cutter; Grade Checker; Utility Pipeline Tapper; Waterline; and Caulker

GROUP 4 - Miner (With Air-pressurized - $1.00 premium); & Gunite Nozzle Person

TUNNEL LABORER WITH AIR-PRESSURIZED ADD $1.00 TO BASE RATE

SIGNAL PERSON WILL RECEIVE THE RATE EQUAL TO THE RATE PAID THE LABORER CLASSIFICATION FOR WHICH HE OR SHE IS SIGNALING.

PAIN0006-002 05/01/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN, PORTAGE (N. of the East-West Turnpike) & SUMMIT (N. of the East-West Turnpike)

	Rates	Fringes
PAINTER		
COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS		
GROUP 1	$ 27.90	16.16
GROUP 2	$ 28.30	16.16
GROUP 3	$ 28.60	16.16
GROUP 4	$ 34.16	16.16
COMMERCIAL REPAINT		
GROUP 1	$ 26.40	16.16
GROUP 2	$ 26.80	16.16
GROUP 3	$ 27.10	16.16

PAINTER CLASSIFICATIONS - COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting; Closed Steel Above 55 feet; Bridges & Open Structural Steel; Tanks - Water Towers; Bridge Painters; Bridge Riggers; Containment Builders

GROUP 4 - Bridge Blaster

PAINTER CLASSIFICATIONS - COMMERCIAL REPAINT

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting

PAIN0007-002 07/01/2019

FULTON, HENRY, LUCAS, OTTAWA (Excluding Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genova) & WOOD

	Rates	Fringes
PAINTER		
NEW COMMERCIAL WORK		
GROUP 1	$ 27.64	17.79
GROUP 2	$ 27.39	17.79
GROUP 3	$ 27.39	17.79
GROUP 4	$ 27.39	17.79
GROUP 5	$ 27.39	17.79
GROUP 6	$ 27.39	17.79
GROUP 7	$ 27.39	17.79
GROUP 8	$ 27.39	17.79
GROUP 9	$ 27.39	17.79

REPAINT IS 90% OF JR

PAINTER CLASSIFICATIONS

GROUP 1 - Brush; Spray & Sandblasting Pot Tender

GROUP 2 - Refineries & Refinery Tanks; Surfaces 30 ft. or over where material is applied to or labor performed on above ground level (exterior), floor level (interior)

GROUP 3 - Swing Stage & Chair

GROUP 4 - Lead Abatement

GROUP 5 - All Methods of Spray

GROUP 6 - Solvent-Based Catalized Epoxy Materials of 2 or More Component Materials, to include Solvent-Based Conversion Varnish (excluding water based)

GROUP 7 - Spray Solvent Based Material; Sand & Abrasive Blasting

GROUP 8 - Towers; Tanks; Bridges; Stacks Over 30 Feet

GROUP 9 - Epoxy Spray (excluding water based)

PAIN0012-008 05/01/2019

BUTLER COUNTY

	Rates	Fringes
PAINTER		
GROUP 1	$ 21.95	10.20
GROUP 2	$ 25.30	10.20
GROUP 3	$ 25.80	10.20
GROUP 4	$ 26.05	10.20
GROUP 5	$ 26.30	10.20

PAINTER CLASSIFICATIONS

GROUP 1: Bridge Equipment Tender; Bridge/Containment Builder

GROUP 2: Brush & Roller

GROUP 3: Spray

GROUP 4: Sandblasting; & Waterblasting

GROUP 5: Elevated Tanks; Steeplejack Work; Bridge; & Lead Abatement

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PAIN0012-010 05/01/2019

BROWN, CLERMONT, CLINTON, HAMILTON & WARREN

	Rates	Fringes
PAINTER		
HEAVY & HIGHWAY BRIDGES-		

GUARDRAILS-LIGHTPOLES-		
STRIPING		
Bridge Equipment Tender and Containment Builder	$ 21.95	10.20
Bridges when highest point of clearance is 60 feet or more; & Lead Abatement Projects	$ 26.30	10.20
Brush & Roller	$ 25.30	10.20
Sandblasting & Hopper Tender; Water Blasting	$ 26.05	10.20
Spray	$ 25.80	10.20

PAIN0093-001 12/01/2018

ATHENS, GUERNSEY, HOCKING, MONROE, MORGAN, NOBLE and WASHINGTON COUNTIES

	Rates	Fringes
PAINTER		
Bridges; Locks; Dams; Tension Towers; & Energized Substations	$ 34.04	18.50
Power Generating Facilities	$ 30.89	18.50

PAIN0249-002 05/01/2019

CLARK, DARKE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
PAINTER		
GROUP 1 - Brush & Roller	$ 23.67	11.50
GROUP 2 - Swing, Scaffold Bridges; Structural Steel; Open Acid Tank; High Tension Electrical Equipment; & Hot Pipes	$ 23.67	11.50
GROUP 3 - Spray; Sandblast; Steamclean; Lead Abatement	$ 24.42	11.50
GROUP 4 - Steeplejack Work	$ 24.62	11.50
GROUP 5 - Coal Tar	$ 25.17	11.50
GROUP 6 - Bridge Equipment Tender & or Containment Builder	$ 32.38	11.50
GROUP 7 - Tanks, Stacks &		

Towers	$ 27.31	11.50
GROUP 8 - Bridge Blaster, Rigger	$ 35.38	11.50

PAIN0356-002 09/01/2009

KNOX, LICKING, MUSKINGUM, and PERRY

	Rates	Fringes
PAINTER		
Bridge Equipment Tenders and Containment Builders	$ 27.93	7.25
Bridges; Blasters; andRiggers	$ 34.60	7.25
Brush and Roller	$ 20.93	7.25
Sandblasting; Steam Cleaning; Waterblasting; and Hazardous Work	$ 25.82	7.25
Spray	$ 21.40	7.25
Structural Steel and Swing Stage	$ 25.42	7.25
Tanks; Stacks; and Towers	$ 28.63	7.25

PAIN0438-002 12/01/2018

BELMONT, HARRISON and JEFFERSON COUNTIES

	Rates	Fringes
PAINTER		
Bridges, Locks, Dams, Tension Towers & Energized Substations	$ 32.80	17.68
Power Generating Facilities	$ 29.65	17.68

PAIN0476-001 06/01/2019

COLUMBIANA, MAHONING, and TRUMBULL COUNITES

	Rates	Fringes
PAINTER		
GROUP 1	$ 25.82	16.58
GROUP 2	$ 32.45	16.58
GROUP 3	$ 26.03	16.58
GROUP 4	$ 26.47	16.58
GROUP 5	$ 26.47	16.58
GROUP 6	$ 26.72	16.58
GROUP 7	$ 27.82	16.58

PAINTER CLASSIFICATIONS:

GROUP 1: Painters, Brush & Roller

GROUP 2: Bridges

GROUP 3: Structural Steel

GROUP 4: Spray, Except Bar Joist/Deck

GROUP 5: Epoxy/Mastic; Spray- Bar Joist/Deck; Working Above 50 Feet; and Swingstages

GROUP 6: Tanks; Sandblasting

GROUP 7: Towers; Stacks

PAIN0555-002 06/01/2019

ADAMS, HIGHLAND, JACKSON, PIKE & SCIOTO

	Rates	Fringes
PAINTER		
GROUP 1	$ 31.04	16.31
GROUP 2	$ 32.50	16.31
GROUP 3	$ 33.96	16.31
GROUP 4	$ 36.82	16.31

PAINTER CLASSIFICATIONS

GROUP 1 - Containment Builder

GROUP 2 - Brush; Roller; Power Tools, Under 40 feet

GROUP 3 - Sand Blasting; Spray; Steam Cleaning; Pressure Washing; Epoxy & Two Component Materials; Lead Abatement; Hazardous Waste; Toxic Materials; Bulk & Storage Tanks of 25,000 Gallon Capacity or More; Elevated Tanks

GROUP 4 - Stacks; Bridges

PAIN0639-001 05/01/2011

	Rates	Fringes
Sign Painter & Erector	$ 20.61	3.50+a+b+c

FOOTNOTES: a. 7 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; Christmas Day & 1 Floating Day
b. Vacation Pay: After 1 year's service - 5 days' paid vacation; After 2, but less than 10 years' service - 10 days' paid vacation; After 10, but less than 20 years' service - 15 days' paid vacation; After 20 years' service - 20 days' paid vacation
c. Funeral leave up to 3 days maximum paid leave for death of mother, father, brother, sister, spouse, child, mother-in-law, father-in-law, grandparent and inlaw provided employee attends funeral

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PAIN0788-002 06/01/2019

ASHLAND, CRAWFORD, ERIE, HANCOCK, HURON, MARION, MORROW, OTTAWA (Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genoa), RICHLAND, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
PAINTER		
Brush & Roller	$ 24.66	14.05
Structural Steel	$ 26.26	14.05

WINTER REPAINT: Between December 1 to March 31 - 90%JR

$.50 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

While working swingstage, boatswain chair, needle beam and horizontal cable. While operating sprayguns, sandblasting, cobblasting and high pressure waterblasting (4000psi).

$1.00 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

For the application of catalized epoxy, including latex epoxy that is deemed hazardous, lead abatement, or for work or material where special precautions beyond normal work duties must be taken. For working on stacks, tanks, and towers over 40 feet in height.

PAIN0813-005 12/01/2008

GALLIA, LAWRENCE, MEIGS & VINTON

	Rates	Fringes
PAINTER		
Base Rate	$ 24.83	10.00
Bridges, Locks, Dams & Tension Towers	$ 27.83	10.00

PAIN0841-001 06/01/2018

MEDINA, PORTAGE (South of and including Ohio Turnpike), and SUMMIT (South of and including Ohio Turnpike) COUNTIES

	Rates	Fringes
Painters:		
GROUP 1	$ 25.75	14.35
GROUP 2	$ 26.40	14.35
GROUP 3	$ 26.50	14.35
GROUP 4	$ 26.60	14.35
GROUP 5	$ 27.00	14.35
GROUP 6	$ 39.20	11.75
GROUP 7	$ 27.00	14.35

PAINTER CLASSIFICATIONS:

GROUP 1 - Brush, Roller & Paperhanger

GROUP 2 - Epoxy Application

GROUP 3 - Swing Scaffold, Bosum Chair, & Window Jack

GROUP 4 - Spray Gun Operator of Any & All Coatings

GROUP 5 - Sandblast, Painting of Standpipes, etc. from Scaffolds, Bridge Work and/or Open Structural Steel, Standpipes and/or Water Towers

GROUP 6 - Public & Commerce Transportation, Steel or Galvanized, Bridges, Tunnels & Related Support Items (concrete)

GROUP 7 - Synthetic Exterior, Drywall Finisher and/or Taper, Drywall Finisher and Follow-up Man Using Automatic Tools

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PAIN0841-002 06/01/2018

CARROLL, COSHOCTON, HOLMES, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
PAINTER		
Bridges; Towers, Poles & Stacks; Sandblasting Steel; Structural Steel & Metalizing	$ 22.78	13.63
Brush & Roller	$ 21.77	13.63
Spray; Tank Interior & Exterior	$ 22.60	13.63

PAIN1020-002 04/01/2019

ALLEN, AUGLAIZE, CHAMPAIGN, DEFIANCE, HARDIN, LOGAN, MERCER, PAULDING, PUTNAM, SHELBY, VAN WERT, and WILLIAMS COUNTIES

	Rates	Fringes
PAINTER		
Brush & Roller	$ 24.57	15.03
Drywall Finishing & Taping	$ 23.27	15.03
Lead Abatement	$ 26.32	15.03
Spray, Sandblasting Pressure Cleaning, & Refinery	$ 25.32	15.03
Swing Stage, Chair, Spiders, & Cherry Pickers	$ 24.82	15.03
Wallcoverings	$ 22.17	15.03

All surfaces 40 ft. or over where material is applied to or labor performed on, above ground level (exterior), floor level (interior) - $.50 premium

Applying Coal Tar Products - $1.00 premium

PAIN1275-002 05/01/2019

DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, MADISON, PICKAWAY, ROSS & UNION

	Rates	Fringes
PAINTER		
Bridges	$ 34.24	14.20
Brush; Roller	$ 24.76	14.20

Sandblasting; Steamcleaning; Waterblasting (3500 PSI or Over)& Hazardous Work	$ 25.46	14.20
Spray	$ 25.26	14.20
Stacks; Tanks; & Towers	$ 28.27	14.20
Structural Steel & Swing Stage	$ 25.06	14.20

PLAS0109-001 05/01/2018

MEDINA, PORTAGE, STARK, and SUMMIT COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0109-003 05/01/2018

CARROLL, HOLMES, TUSCARAWAS, and WAYNE COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLAS0132-002 05/01/2018

BROWN, BUTLER, CLERMONT, HAMILTON, HIGHLAND, WARREN COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0404-002 05/01/2018

ASHTABULA, CUYAHOGA, GEAUGA, AND LAKE COUNTIES

	Rates	Fringes
PLASTERER	$ 29.63	17.11

PLAS0404-003 05/01/2018

LORAIN COUNTY

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0526-022 05/01/2018

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0526-023 05/01/2018

BELMONT, HARRISON, and JEFFERSON COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLAS0886-001 05/01/2018

FULTON, HANCOCK, HENRY, LUCAS, PUTNAM, and WOOD COUNTIES

	Rates	Fringes
PLASTERER	$ 29.63	17.11

PLAS0886-003 05/01/2018

DEFIANCE, ERIE, HURON, OTTAWA, PAULDING, SANDUSKY, and SENECA COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0886-004 05/01/2018

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, and VAN WERT COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLUM0042-002 07/01/2018

ASHLAND, CRAWFORD, ERIE, HURON, KNOX, LORAIN, MORROW, RICHLAND & WYANDOT

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 34.20	22.07

PLUM0050-002 07/01/2019

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 42.00	26.73

PLUM0055-003 04/29/2019

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, MEDINA (N. of Rte. #18 & Smith Road) & SUMMIT (N. of Rte. #303, including the corporate limits of the city of Hudson)

	Rates	Fringes
PLUMBER	$ 36.55	26.74

PLUM0083-001 07/01/2017

BELMONT & MONROE (North of Rte. #78)

	Rates	Fringes
Plumber and Steamfitter	$ 32.16	31.51

PLUM0094-002 05/01/2019

CARROLL (Northen Half), STARK, and WAYNE COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 35.78	20.14

PLUM0120-002 04/30/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN (the C.E.I. Power House in Avon Lake), MEDINA (N. of Rte. #18) & SUMMIT (N. of #303)

	Rates	Fringes
PIPEFITTER	$ 37.67	22.42

PLUM0162-002 01/01/2020

CHAMPAIGN, CLARK, CLINTON, DARKE, FAYETTE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 31.25	25.52

PLUM0168-002 06/01/2019

MEIGS, MONROE (South of Rte. #78), MORGAN (South of Rte. #78) & WASHINGTON

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 35.32	31.63

PLUM0189-002 06/01/2019

DELAWARE, FAIRFIELD, FRANKLIN, HOCKING, LICKING, MADISON, MARION, PERRY, PICKAWAY, ROSS & UNION

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 38.45	16.98

PLUM0219-002 05/31/2018

MEDINA (Rte. #18 from eastern edge of Medina Co., west to eastern corporate limits of the city of Medina, & on the county road from the west corporate limits of Medina running due west to and through community of Risley to the western edge of Medina County - All territory south of this line), PORTAGE, and SUMMIT (S. of Rte. #303) COUNTIES

	Rates	Fringes
Plumber and Steamfitter	$ 37.02	23.79

PLUM0392-002 06/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON & WARREN

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 32.81	21.27

PLUM0396-001 06/01/2019

COLUMBIANA (Excluding Washington & Yellow Creek Townships & Liverpool Twp. - Secs. 35 & 36 - West of County Road #427), MAHONING and TRUMBULL COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 34.00	25.46

PLUM0495-002 06/01/2018

CARROLL (Rose, Monroe, Union, Lee, Orange, Perry & Loudon Townships), COLUMBIANA (Washington & Yellow Creek Townships & Liverpool Township, Secs. 35 & 36, West of County Rd. #427), COSHOCTON, GUERNSEY, HARRISON, HOLMES, JEFFERSON, MORGAN (South to State Rte. #78 & from McConnelsville west on State Rte. #37 to the Perry County line), MUSKINGUM, NOBLE, and TUSCARAWAS COUNTIES

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 38.24	23.09

PLUM0577-002 06/01/2019

ADAMS, ATHENS, GALLIA, HIGHLAND, JACKSON, LAWRENCE, PIKE, SCIOTO & VINTON

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 34.90	24.11

PLUM0776-002 08/01/2019

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY and VAN WERT COUNTIES

	Rates	Fringes

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 36.64	24.73

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* TEAM0377-003 05/01/2020

STATEWIDE, EXCEPT CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 28.89	15.40
GROUP 2	$ 29.31	15.40

TRUCK DRIVER CLASSIFICATIONS

GROUP 1 - Asphalt Distributor; Batch; 4- Wheel Service; 4-Wheel Dump; Oil Distributor & Tandem

GROUP 2 - Tractor-Trailer Combination: Fuel; Pole Trailer; Ready Mix; Semi-Tractor; & Asphalt Oil Spraybar Man When Operated From Cab; 5 Axles & Over; Belly Dump; End Dump; Articulated Dump; Heavy Duty Equipment; Low Boy; & Truck Mechanic

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TEAM0436-002 05/01/2019

CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 28.40	16.95
GROUP 2	$ 28.90	16.95

GROUP 1: Straight & Dump, Straight Fuel

GROUP 2: Semi Fuel, Semi Tractor, Euclids, Darts, Tank, Asphalt Spreaders, Low Boys, Carry-All, Tourna-Rockers, Hi-Lifts, Extra Long Trailers, Semi-Pole Trailers, Double Hook-Up Tractor Trailers including Team Track & Railroad Siding, Semi-Tractor & Tri-Axle Trailer, Tandem Tractor & Tandem Trailer, Tag Along Trailer, Expandable Trailer or Towing Requiring Road Permits, Ready-Mix (Agitator or Non-Agitator), Bulk Concrete Driver, Dry Batch Truck, Articulated End Dump

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198

indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

THIS SECTION IS BEING ISSUED AS PART OF ADD #4

SECTION 08 1114

STAINLESS STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required for stainless steel doors and frames as shown and specified.

B. The extent of stainless steel doors and frames is shown on the Drawings.

C. The types of stainless steel door and framework required may include the following:
   1. Fire-rated flush doors and frames

D. Related Sections:
   1. Section 05501, Anchor Bolts, Expansion Anchors and Concrete Inserts
   2. Section 08710, Finish Hardware

1.2 REFERENCES

A. Reference Standards:
   1. ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
   2. MIL-PRF-24635, Coating Systems, Weather-Resistant, Exterior Use
   3. National Association of Architectural Metal Manufacturers (NAAMM), Hardware Location for Custom Stainless Steel Doors
   4. NFPA No. 80, Standard for Fire Doors and Windows
   5. SDI 250.6, Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
   6. SDI 250.8, Recommended Specifications for Standard Steel Doors and Frames
   7. SDI 250.11, Recommended Erection Instructions for Steel Frames
   8. UL 10B, Standard for Fire Tests of Door Assemblies
   9. UL 63, Fire Door Frames

1.3 SUBMITTALS

A. Shop Drawings:
   1. Submit Shop Drawings, including details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections for the fabrication and installation of stainless steel doors and frames.
   2. Provide a schedule of doors and frames using same reference numbers for details and openings as those on the Drawings.

B. Warranties and Guarantees: Submit a written guarantee stating compliance with the requirements of paragraph 1.11 of this Section.

C. Quality Assurance/Control Submittals:
   1. Certificates:

a. Submit UL certification of construction for doors and frames not requiring labels but requiring labeled construction.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Provide stainless steel doors and frames and accessories manufactured by a single firm specializing in the production of this type of work.
   2. Comply with all applicable standards of the Steel Door Institute recommended specifications for Standard Steel Doors and Frames (SDI 250.8).
   3. Reinforce doors and frames for all hardware to comply with SDI 250.6.
   4. Erect frames per SDI 250.11.

B. Regulatory Requirements:
   1. Identify each fire door and frame with recognized testing laboratory labels, indicating applicable fire rating of both door and frame.

C. Temperature Rise Rating: Comply with UL 10B for temperature ratings as specified.

D. Construct assemblies to comply with NFPA Standard No. 80, and as specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver stainless steel doors and frames cartoned or crated to provide protection during transit and job storage.

B. Do not deliver stainless steel doors and frames to job site until work has progressed to the point where doors may be installed without high risk of damage due to construction activities.

C. Store doors and frames at the building site on sills or blocking in a manner that will prevent rusting.

D. Remove from the job site frames that are bowed, twisted or otherwise unacceptable. Replace with properly constructed frames.

1.6 WARRANTY

A. Manufacturer's Extended Express Warranty
   1. The manufacturer shall replace at no cost to the Owner, stainless steel doors and frames which fail in materials or workmanship within 2 years of the date of Substantial Completion.
   2. Failure of materials or workmanship shall include (but not be limited to)failures in operation of doors and hardware, excessive leakage or air infiltration, excessive deflections, deterioration of finish or metal in excess of normal weathering, and defects in accessories, weather-stripping, and other components of the work.

1.7 MAINTENANCE

A. The Contractor and door installer shall return to the Project approximately 6 months and 12 months after the acceptance of the door installation in each area and shall inspect each door for

rubbing, misalignment, or other deficiencies which have occurred due to normal operation or any other cause.

1. All such deficiencies shall be immediately corrected and the doors readjusted to restore the proper operation and function.
2. If such repairs cannot be made, the Contractor shall furnish and install a completely new replacement door, including all new hardware, at no additional cost to the Owner, for each such irreparable door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products and Manufacturers for Fire-Rated Doors:
   1. Stainless Steel Doors by Next Door Company
   2. Or approved equal.

B. Manufacturers for Fire-Rated Frames:
   1. Fire Rated Frames by Next Door Company
   2. Or approved equal.

2.2 MATERIALS

A. Frames: Type 316 stainless steel.

B. Door Faces and Frames:

C. Type 316 stainless steel sheets.

D. Supports and Anchors: Stainless Steel, Type 316.

E. Inserts, Bolts and Fasteners: Stainless steel, Type 316.

F. Concrete Anchorage: Comply with Section 05501, Anchor Bolts, Expansion Anchors and Concrete Inserts.

G. All internal webs, members, reinforcements, anchors and plates shall be Type 316 stainless steel.

2.3 FABRICATION

A. General:
   1. Fabricate stainless steel units to be rigid, neat in appearance and free from defects, warp or buckle.
      a. Accurately form metal to required sizes and profiles.
      b. Fit and assemble units in the manufacturer's plant wherever practicable.
      c. Clearly identify work that cannot be permanently factory-assembled before shipment to assure proper assembly at the site.
      d. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible.
      e. Filling to conceal manufacturing defects is not acceptable.

2. Exposed Fasteners: Provide countersunk flat Phillips or Jackson heads for exposed screws and bolts unless otherwise specified.
3. Finish Hardware Preparation:
   a. Prepare stainless steel units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with final finish hardware schedule and templates provided by hardware supplier.
   b. Comply with applicable ANSI A115 Specifications for Door and Frame Preparation for Hardware.
   c. Reinforce stainless steel units to receive surface-applied hardware.
   d. Drilling and tapping for surface-applied finish hardware may be done at site.
   e. Locate finish hardware as shown on reviewed Shop Drawings, in accordance with hardware templates provided by hardware manufacturer and in accordance with National Association of Architectural Metal Manufacturers, Hardware Locations for Custom Stainless Steel Doors. Refer to Section 08 71 00, Door Hardware.

B. Doors:
1. Door Types:
   a. Provide doors, with lites, as specified and shown on the Drawings.
   b. Provide 1 3/4-inch thick flush seamless stainless steel construction doors where shown.
2. Door Construction:
   a. Type 316 Stainless Steel Doors:
      1) Fabricate doors of 2 outer stretcher-leveled 18-gage minimum stainless steel sheets.
      2) Construct doors with smooth, flush surfaces, fully welded without visible joints or seams on exposed faces and stile edges. No fillers shall be used.
      3) Provide weep hole openings in the bottom of exterior doors to release entrapped moisture.
   b. Reinforcing:
      1) Reinforce inside of doors with phenolic resin impregnated kraft 1-inch hexagonal cell honeycomb core completely filling the inside of both face panels.
      2) The honeycomb material shall have a crushing strength of 4000 psf minimum and the lamination shall withstand 1100 psf minimum in shear.
      3) Door reinforcement may be modified in fabrication method to provide a UL labeled
         a) 1 1/2-hour (B) fire rated door.
      4) Reinforce tops and bottoms of doors with flush-mounted 16-gage minimum horizontal stainless steel channels welded continuously to the outer sheets.
      5) Provide weather seal by integral closing top and bottom edges or by addition of inverted stainless steel channels
   c. Provide edge profiles on both stiles of doors beveled 1/8 inch in 2 inches.
3. Finish Hardware Reinforcement:
   a. Refer to Section 08710, Finish Hardware, for finish hardware.
   b. Hardware supplier shall furnish stainless steel door and frame manufacturer approved hardware schedule, hardware templates and samples of physical hardware where necessary to insure correct fitting and installation.

c. Preparation includes sinkages and cutouts for mortise and concealed hardware.
d. Provide reinforcements for both concealed and surface applied hardware:
   1) Drill and tap mortise reinforcements at factory using templates.
   2) Install reinforcements with concealed connections designed to develop full strength of reinforcements.
e. Reinforce doors with Type 316 stainless steel sheet or plate for required finish hardware as follows:
   1) Hinges: 7 gage thick plate 1 1/2 inches wide by 6 inches longer than hinge secured by 6 minimum spot or projection welds.
   2) Mortise Locksets and Dead Bolts: 14-gage sheet secured with 2 minimum spot or projection welds.
   3) Cylinder Locks: 12-gage sheet secured with 2 minimum spot or projection welds.
   4) Flush Bolts: 12-gage sheet secured with 2 minimum spot or projection welds.
   5) Surface-Applied Closers: 12-gage sheet secured with 2 minimum spot or projection welds.
   6) Push Plates and Bars: 16-gage sheet secured with 6 minimum spot or projection welds.
   7) Surface Panic Devices: 16-gage sheet secured with minimum of 6 spot or projection welds.

C. Stops and Moldings:
1. Provide stops and moldings around solid, glazed and louvered panels in stainless steel units and in frames to receive glass, where shown.
2. Form fixed stops and moldings integral with frame. Provide fixed stops on inside of stainless steel units exposed to exterior and on corridor side of interior units.
3. Provide removable stops and molds at other locations, formed of not less than galvanized 20-gage steel sheets. Secure with countersunk machine screws spaced uniformly not more than 12 inches on center. Form corners with butted hairline joints.
4. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated. Refer to Section 08800, Glazing.

D. Fire-Rated Doors:
1. Comply with door construction specified and UL requirements.
2. Provide fire-rated doors in accordance with Underwriters' Laboratories Standard, UL 10B, and NFPA No. 80.
   a. Provide doors with temperature rise rating of not more than 250°F maximum to 30 minutes of exposure for UL 3-hour (A) classification.
   b. Provide doors with temperature rise rating of not more than 450°F or 650°F maximum to 30 minutes of exposure for UL 1 1/2-hour (B) classification.

E. Frames:
1. Frame Types:
   a. Provide stainless steel frames for doors as shown or specified.
   b. Provide fire-rated frames in accordance with UL Standards UL 10B and UL 63 and NFPA Pamphlet No. 80 and as listed in UL.
   c. Form frames of 16-gage Type 316 stainless steel for all stainless steel doors:
      1) Hinge Reinforcement: 1 1/2 inches wide by 6 inches longer than hinge, secured by 6 minimum spot or projection welds.

2) Strike Plate Clips: 10-gage thick plate 1 1/2 inches wide by 3 inches long.
3) Surface-Applied Closer Reinforcement: 12 gage sheet secured with 6 minimum spot or projection welds.
4) All reinforcement shall be Type 316 stainless steel.

d. Head Reinforcing: Leave vertical mullions in frames open at the top where installed in masonry so they can be filled with grout.

e. Jamb Anchors, In-Place Concrete or Masonry:
1) Anchor frame jambs with 3/8-inch minimum concealed bolts into expansion shields or inserts at 24 inches on center between 6 inches from top and bottom.
2) Reinforce frames at anchor locations.
3) Apply removable stop to cover anchor bolts.
4) Provide clip type floor anchors formed of 14-gage stainless steel with holes to receive fasteners.

f. Jamb Anchors, New Masonry:
1) Provide manufacturer's standard "T" type anchors.
2) Comply with Section 04200, Unit Masonry Construction. Anchor frame at every second horizontal masonry joint.
3) Fill frame solidly with mortar as masonry construction progresses.

2. Fire-Rated Frames:
a. Provide the same construction specified above for frames and within UL and NFPA requirements.

2.4 FINISHES

A. Preparation:
1. Prepare the stainless steel surfaces for finishing in accordance with the stainless steel producer's recommendations and standards of the finisher or processor after fabrication of doors and frames but before coating of panels.
2. Process all components of each assembly for the Project simultaneously to attain complete color uniformity.

B. Finish:
1. Doors and Frames:
a. Finish for all surfaces to receive finish painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examination and Verification of Condition: Contractor must examine the substrate and conditions under which stainless steel doors and frames are to be installed and review with CMT any conditions detrimental to the proper and timely completion of the work.

B. Do not proceed with the work until deficiencies have been corrected.

3.2 INSTALLATION

A. Install stainless steel units and accessories in accordance with Shop Drawings, manufacturer's data, and as shown and specified.

B. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.

C. Placing Frames:
   1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set.
   2. Remove temporary braces and spreader bars leaving surfaces smooth and undamaged only after frames have been properly set and secured and wall construction is complete.
   3. Weld and finish field splices in frames to match factory work as detailed on reviewed Shop Drawings.

D. Door Installation:
   1. Fit stainless steel doors accurately in their respective frames using the following clearances:
      a. Jambs and Head: 3/32 inch.
      b. Meeting Edges, Pairs of Doors: 1/8 inch.
      c. Bottom, no threshold or carpet: 3/4 inch.
      d. Bottom, threshold or carpet: 1/8 inch.
   2. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.
   3. Finish Hardware Installation: Comply with Section 08710, Finish Hardware.

3.3 ADJUSTING

A. Final Adjustments:
   1. Check and readjust operating finish hardware items in stainless steel work just prior to final inspection.
   2. Leave work in complete and proper operating conditions.

3.4 PROTECTION

A. Protect installed stainless steel doors and frames against damage from other construction activities.

+ + END OF SECTION + +

THIS SECTION IS BEING ISSUED AS PART OF ADD #4

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TO ALL DOCUMENT HOLDERS:

Subject: WCWSD RARWTP Membrane Softening Upgrades

AECOM Job No.: 60551697

Enclosed herewith is a copy of Addendum No. 3 covering the subject project.

Please retain this with your Documents.

Sincerely,

AECOM

Matthew Noelker, P.E.

Attachments:

Specifications

1. Section 00 4113 Bid Form
2. Section 46 3393.01 Polyethylene Chemical Storage Tanks and Appurtenance Schedule

Drawings

1. Sheet GP-01
2. Sheet GP-04
3. Sheet GP-05
4. Sheet GP-10
5. Sheet GP-18

ADDENDUM TO THE
BIDDING DOCUMENTS
FOR:
WCWSD RARWTP Membrane Softening Upgrades

1.1 GENERAL

A. This Addendum covers changes to the Documents and in closing the Contract will become a part thereof. Each Bidder shall include these items to the extent they affect his Bid.

B. These items modify only the portion of the Documents specifically noted. All other wording and Drawings remain in effect.

1.2 CLARIFICATIONS

A. The following is a list of clarifications regarding project documents. These clarifications include questions received during the advertisement period:

C: Davis Bacon Heavy Highway Rates shall be used. Revised wage rates will be issued in the final addendum.

C: Substitution requests included in section 00 4325 will not be considered in the basis of award.

C: Contractor only has to provide the chemical specified in 43 0630.

C: Non-structural steel, or miscellaneous metals, can be supplied by a non-AISC shop.

C: Primary Sensors and Field Instruments are listed in Specification 40 9100 Primary Sensors and Field Instruments Attachment. Pressure Gauges are listed in sheet GP-18 and covered in 40 0523 paragraph 2.9.C. Remaining schedules on sheet GP-18 are by the NF OEM.

Q: Please clarify the integrated spring loaded check valve body material required for the Saf-T-Flo EB-146 injection quills listed in the RARWTP Metering Pump Schedule with section 463344.

A: The check valve is integral to the solution tube. Solution tube materials are listed in 46 3344 RARWTP Metering Pump Schedule.

Q: Can excess spoils remain on site both at the outfall and up at the treatment plant?

A: Excess spoils at the outfall will need to be hauled off site.

Q: Where can the material specification and insulation schedule for process piping be located?

A: Please refer to 40 0513, paragraph 2.5.

Q: Can trees from the outfall work be mulched and left on site or do they need to be hauled off site?

A: Trees can be mulched and left on site.

Q: On sheet no. PD-02 all three pressure gauge details show diaphragm seals. Is every pressure gauge supplied on this project to have a diaphragm seal?

A: Yes, all gauges are to have a diaphragm seal.

Q: What are the outlet connections of the degasifier towers?

A: The degasifier is supplied with a vortex breaker and installed inside of the effluent pipe of the degasifier. There will need to be a slightly oversized sleeve thru the concrete floor. There will be a short piece of down comer pipe and a loose flange that will be glued in the field after the down comer pipe is installed. Typically when the degasification tower is lifted in the air for installation, the down comer pipe is glued into the receiving coupling that is flush with the bottom of the degasification tower bottom. Both pieces are standard PVC material. Once the down comer pipe is glued into the receiver the degasification tower is guided over the hole or sleeve in the concrete and lowered into position. Once placed and level the degasification tower can be secured by anchoring thru the FRP anchor cleats.

Q: To access the wellfield/aerator site, can contractors use the bike path? Will a permit be needed to cross?

A: Yes, contractors should coordinate with ODNR, a specific permit will not be needed as the Client has a license agreement. A unit price line item has been added to the Bid Form.

Q: Section 01 7500 paragraph 1.3.9 states for the contractor to provide all materials necessary to conduct tests, unless otherwise indicated. Are contractors required to pay for the power on testing?

A: Contractor is responsible for temporary power through substantial completion.

Q: Dwg 1P-07 appears to show the 8" CSF, CSPR & CSCR lines with Vic fittings. The pipe schedule on GP-17 indicates pipe material for the lines as SCH 80 PVC. Please clarify pipe material & joint types for these 3 NF Building lines.

A: Pipes less than 8-inch in diameter shall be socket welded. Pipes 8-inches and larger in diameter shall have grooved joints. Refer to 40 0513 paragraph 2.2.E.7.

Q: What is the pipe material for the 18" NFP line shown with VIC Couplings on 1P-10?

A: 18-inch NFP shall be SCH 80 PVC from the skids to BFV-5001 as shown on sheet GP-06.

Q: Is the Automatic Transfer Switch designed for front or side access?

A: The ATS will have front and side accesses as shown on Sheet E-09. The front of the ATS faces MCC-6.

Q: Drawing E-06 Membrane Cleaning system control panel shown at the bottom of the page. Only one of the conduits is identified/labeled. Please identify the others.

A: MCS conduits were originally under the membrane OEM scope since they were providing the MCS system. That scope of conduits and wires were switched to the electrical contractor's scope via Coded Note 16, added in Addendum 2. Conduit numbers will be worked out during construction.

Q: On sheet 1P-08 the NFP Line (18" and 24") is shown to be SCH 80 PVC with grooved joints south of the butterfly valve tagged BF-5001. Per Victaulic PVC fittings are not available for anything over 12", they can only provide the couplings. Please review and advise as to how we are to proceed. We assume that it is not your intent to have any grooved splices in these larger diameter piping systems if the fittings have to be solvent welded.

A: Solvent welded fittings are acceptable at all locations. Joints (where required) shall be grooved for pipes 8-inches and larger per 40 0513 paragraph 2.2.E.7.b.

Q: Are window blinds required? They are specified in section 12 2100, but nothing appears to be shown on the drawings.

A: Window blinds will be required for the two exterior windows in the control room.

Q: Are visual boards required? They are specified in Section 10 1100, but nothing appears to be shown on the drawings.

A: Visual display boards will be located in the control room, location not shown on drawings.

Q: Will elevations of the aluminum & hollow windows be provided?

A: Elevations of exterior windows are provided on sheets A-06 and A-07. Interior window elevation is provided on section K on sheet A-11.

Q: For the fire alarm system, there is a fire alarm panel on the drawing but no devices. Is there a list of fire alarm devices and placement of these available? Is the fire alarm system designed by the fire alarm supplier or does the electrical designer have the design?

A: There are no fire alarm devices shown on the Drawings, the system will be designed by the fire alarm system supplier.

Q: For fire alarm systems, the specifications calls for a system printer, graphic annunciator, voice fire alarm extra materials maintenance agreement and training. Are all of these required?

A: The system components should be bid as specified.

C: For fire alarm systems there are not any hazardous locations that would require explosion proof devices.

1.3 PROJECT MANUAL

A. Section 00 4113 Bid Form
   1. This Section is being revised and reissued as an attachment to this addendum.

B. Section 00 4333 Proposed Products Form
   1. LIST OF PROPOSED MANUFACTURERS – Modify the following Declared Manufacturers as follows:
      a. For Motor Control Centers
         1) Remove "Square D"
      b. For the Vertical Turbine Pumps and Appurtenances Item
         1) Add "Fairbanks Morse"
      c. For the Cartridge Filters Item:
         1) Remove "Nowata"
         2) Add "Piedmont"

C. Section 08 7100 Door Hardware
   1. Paragraph 3.5.B – Modify the following text to include:
      a. "9. Set 9: Doors: R107-3, R108-3, R109-3

Qty	Description
2	Hinges
1	Closer
1	Lockset - Entrance
3	Silencers
1	Threshold
1	Weatherstripping"

D. Section 40 0513 Process Piping
   1. Paragraph 2.2.E.7.b.1 – Delete and replace with the following:
      a. "Grooved joints and socket welded fittings"
   2. Paragraph 2.2.E.7.b.6 – Modify the following text to read:
      a. "Basis of Design: Victaulic Style 357 for piping 8" and smaller and Victaulic style 77 for piping larger than 8"."
   3. Paragraph 2.3.A.1 – Delete subparagraphs a and b and replace with:
      a. "a. Pipe shall conform to ASTM A 778 in the NPS size shown with dimensional tolerances per ASTM A530."
      b. "b. Fittings shall conform to ASTM A 774 and be of the same thickness and material as the pipe. Socket weld fittings are not acceptable."
   4. Paragraph 2.3.A.2 – Delete subparagraphs a, c, and d.

E. Section 41 2200 Cranes and Hoists
   1. Paragraph 2.2.B – Remove the following text:
      a. "2. Max Lift: 15 feet."

F. Section 43 2100.02 Vertical Turbine Pumps and Appurtenances

1. Paragraph 2.2.A. – Modify the following text to read:
   a. "4. Fairbanks Morse".
2. Paragraph 2.4.L.5. – Modify the text to include "316 SST"
3. RARWTP Pump Schedule – Paragraph B.6. – Replace "330 feet" to "310 feet".

G. Section 43 2121 Chemical Transfer Pumps
   1. Paragraph 1.2. – Modify the following text to read:
      a. "C. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
         1) Function Testing: 0.5 person days
         2) Field Performance Testing: 0.5 person days".

H. Section 43 1251 Compressed Air System
   1. Paragraph 1.3. – Modify the following text to read:
      a. "B. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
         1) Function Testing and Field Performance Testing: 0.5 person days.".

I. Section 46 3323 Liquid Chemical Weighing Equipment
   1. RARWTP Scale Schedule – Modify the following text to read:
      a. Paragraph A.4 – "Capacity: 0-2000 lbs".
      b. Paragraph B.4 – "Capacity: 0-1000 lbs".
      c. Paragraph C.4 – "Capacity: 0-8000 lbs".
      d. Paragraph D.4 – "Capacity: 0-1500 lbs".

J. Section 46 3344 Chemical Peristaltic Metering Pumps and Appurtenances
   1. Paragraph 2.2 – Modify the text to read:
      a. "C. Metering pump panels shall come preassembled from manufacturer. Field assembled panels are not acceptable."

K. Section 46 3393.01 Polyethylene Chemical Storage Tanks and Appurtenances
   1. RARWTP Tank Schedule –Replace this section in its entirety with the revised Section 46 3393.01 Polyethylene Chemical Storage Tanks and Appurtenances RARWTP Tank Schedule included in this addendum.

L. Section 46 6320 Cartridge Filters
   1. Paragraph 2.4.A.7 – Delete this paragraph.

1.4 DRAWINGS

A. Sheet GP-01
   1. This sheet is being revised and Reissued as an attachment to this addendum.

B. Sheet GP-04
   1. This sheet is being revised and Reissued as an attachment to this addendum.

C. Sheet GP-05
   1. This sheet is being revised and Reissued as an attachment to this addendum.

D. Sheet GP-10

1. This sheet is being revised and Reissued as an attachment to this addendum.

E. Sheets GP-11, 12, & 13
   1. Revise Day tank volume to match revised sizes on sheet GP-01 and Section 46 3393.01 Polyethylene Chemical Storage Tanks and Appurtenances Schedule, reissued as part of this addendum.
   2. These sheets are not being Reissued as part of this addendum.

F. Sheet GP-17
   1. Modify the piping schedule to include a row as follows:
      a. "6" Recirc." - "Membrane Cleaning System Recycle" - "SCH 80 PVC"
   2. This sheet is not being Reissued as part of this addendum.

G. Sheet GP-18
   1. This sheet is being revised and Reissued as an attachment to this addendum.

H. Sheet 1P-14
   1. Remove equipment pads for the future break tank pumps.
   2. This sheet is not being Reissued as part of this addendum.

I. Sheets 2P-04, 05, 06, 09, 11, 13, 20, & 21
   1. Replace day tank with revised size as specified in Section 46 3393.01 Polyethylene Chemical Storage Tanks and Appurtenances Schedule, reissued as part of this addendum.
   2. Revise scale size as required to accommodate revisions in Section 46 3323 Liquid Chemical Weighing Equipment, as part of this addendum.
   3. These sheets are not being Reissued as part of this addendum.

J. Sheet A-14
   1. Modify door schedule for R106-1, replace hardware set "5" with "3"
   2. Modify door schedule for R107-3, R108-3, & R109-3, specify hardware set as "9"
   3. This sheet is not being Reissued as part of this addendum.

K. Sheet S-03
   1. Remove concrete pads for future NF skids, only 6 pads should be provided.
   2. This sheet is not being Reissued as part of this addendum.

L. Sheet MP-01
   1. Replace plan note "SEE DETAIL 1 ON DWG XX-XX." with "SEE SECTION E ON SHEET S-05."
   2. This sheet is not being Reissued as part of this addendum.

END OF ADDENDUM NO. 3
(SEE ENCLOSURES)

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

SECTION 00 4113

BID FORM

TABLE OF CONTENTS

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted via hand delivery, USPS, UPS or FedEx to:

Warren County Administration Building
406 Justice Drive
Lebanon, OH 45036

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – BIDDER'S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 90 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 – BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, other related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date

B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Bidder has carefully studied all: drawings and applicable reports of physical conditions relating to existing surface or subsurface conditions at the Site.

E. Bidder has considered the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by

Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents; and (3) Bidder's safety precautions and programs.

F. Based on the information and observations referred to in Paragraph 3.01.E above, Bidder does not consider that further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.

ARTICLE 4 – BIDDER'S CERTIFICATION

4.01 Bidder certifies that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

ARTICLE 5 – BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

A. General Trades

_____	Dollars	$ _____
(Words)		(Figures)

5.02 Allowances:

A. Tools and Maintenance Equipment

Fifteen thousand	Dollars	$ 15,000.00
(Words)		(Figures)

B. Office Furniture

Ten thousand	Dollars	$ 10,000.00
(Words)		(Figures)

C. Materials Testing

Forty thousand	Dollars	$ 40,000.00
(Words)		(Figures)

D. Local Utility Company

Forty thousand	Dollars	$ 40,000.00
(Words)		(Figures)

E. Trailer Mounted Valve Operator

Fifteen thousand	Dollars	$ 15,000.00

F. Security System

Seventy thousand	Dollars	$ 70,000.00
(Words)		(Figures)

G. NFC Cleanouts and CCTV

Forty-five thousand	Dollars	$ 45,000.00
(Words)		(Figures)

H. Lab Equipment

Five thousand	Dollars	$ 5,000.00
(Words)		(Figures)

I. SCADA

Twenty thousand	Dollars	$ 20,000.00
(Words)		(Figures)

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

ADD #3

5.03 **Unit Prices**

A. Bike Path Replacement: Bike path access from Grandin Road to the site of the proposed Cascade Aerator is acceptable. The County has a license agreement with ODNR for access to their wellfield, however, Contractor should coordinate with ODNR prior to access. Contractor shall include a unit price per linear foot of bike path replacement after completion of all construction at the site of the Cascade Aerator. Pavement section shall consist of 1.5-inches of ODOT No. 448 (asphalt concrete surface course, medium traffic, type 1, PG64-22) overtop 3-inches of ODOT No. 301 (asphalt concrete base, PG64-22). Width of bike path is 10-feet. Unit price shall include removal of 4.5-inches of existing asphalt, compaction/leveling, placement of new asphalt, and striping.

ITEM	UNIT	ESTIMATED QUANTITY	BID UNIT PRICE (figures)	TOTAL BID PRICE
Bike Path Replacement	**LF**	**4,300**	**$_____**	**$_____**

5.04 ~~**Base Bid Plus Allowances**~~ **Base Bid Plus Allowances Plus Unit Prices:**

_____ Dollars _____
(Words) (Figures)

5.05 Alternates

A. No Alternates.

ARTICLE 6 – TIME OF COMPLETION

6.01 Bidder agrees that the Work will be substantially complete within the number of calendar days specified in Section 00 5215 "Agreement between Owner and Contractor" after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and will be completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within the number of calendar days specified in 00 5215 after the date when the Contract Times commence to run.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 – ATTACHMENTS TO THIS BID

7.01 The following documents are submitted with and made a condition of this Bid:

A. See Section 00 4393.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

ARTICLE 8 – DEFINED TERMS

8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

BID SUBMITTAL

8.02 This Bid is submitted by:

If Bidder is:

An Individual

Name (typed or printed): _____

By: _____
(Individual's signature)

Doing business as: _____

A Partnership

Partnership Name: _____

By: _____
(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed): _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____
Type (General Business, Professional, Service, Limited Liability):_____

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____
(CORPORATE SEAL)

Attest _____

Date of Qualification to do business in Ohio is ____/____/____.

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

A Joint Venture

Name of Joint Venture: _____

First Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of first joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Second Joint Venturer Name: _____(SEAL)

By: _____
(Signature of second joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

Bidder's Business Address _____

_____

Phone No. _____ Fax No. _____

E-mail _____ _____

SUBMITTED on _____, 20____.

END OF SECTION 00 4113

THIS SECTION IS BEING REVISED AND REISSUED AS PART OF ADD #3

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THIS SECTION IS BEING REVISED AND REISSED AS PART OF ADD #3

RARWTP TANK SCHEDULE

A. Sodium Bisulfite ($NaHSO_3$)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): ~~**100 ga**~~l **155 gal**
      c. Diameter (max): ~~**1'-11"**~~ **2'-7"**
      d. Height (max): ~~**5'-7"**~~ **4'9"**
   2. Bulk Tank
      a. Quantity: Two (2)
      b. Volume (min): 2,750 gal
      c. Diameter (max): 8'-2"
      d. Height (max): 9'-3"

B. Antiscalant (A.S.)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): ~~**30 gal**~~ **55 gal**
      c. Diameter (max): 1'-11"
      d. Height (max): ~~**2'-2"**~~ **3'-3"**

C. Sodium Hypochlorite (NaOCl)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): ~~**685 gal**~~ **755 gal**
      c. Diameter (max): ~~**5'-1"**~~ **5'6"**
      d. Height (max): ~~**5'-4"**~~ **5'10"**
   2. Bulk Tank
      a. Quantity: Three (3)
      b. Volume (min): 6,100 gal
      c. Diameter (max): 10'-0"
      d. Height (max): 12'-8"

D. Sodium Hydroxide (NaOH)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): ~~**280 gal**~~ **615 gal**
      c. Diameter (max): ~~**2'-10"**~~ **4'0"**
      d. Height (max): ~~**7'-1"**~~ **7'5"**
   2. Bulk Tank
      a. Quantity: Two (2)
      b. Volume (min): 3,000 gal
      c. Diameter (max): 7'-1"
      d. Height (max): 12'-0"

E. Corrosion Inhibitor (PHOS.)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): 155 gal
      c. Diameter (max): 2'-7"
      d. Height (max): 4'-9"

2. Bulk Tank
   a. Quantity: Two (2)
   b. Volume (min): 3,000 gal
   c. Diameter (max): 7'-1"
   d. Height (max): 12'-0"

F. Fluoride (FLUOR.)
1. Day Tank
   a. Quantity: One (1)
   b. Volume (min): ~~**60 gal**~~ **100 gal**
   c. Diameter (max): 1'-11"
   d. Height (max): ~~**3'-6"**~~ **5'7"**
2. Bulk Tank
   a. Quantity: Two (2)
   b. Volume (min): 1,150 gal
   c. Diameter (max): 5'-4"
   d. Height (max): 8'-6"

G. Membrane Cleaning System (MCS)
1. Stage 1- Conical Bottom, Closed-top
   a. Quantity: One (1)
   b. Volume (min): 3,600 gal
   c. Diameter (max): 8'-6"
   d. Height (max): 11'-3"
2. Stage 2- Conical Bottom, Closed-top
   a. Quantity: One (1)
   b. Volume (min): 2,500 gal
   c. Diameter (max): 7'-11"
   d. Height (max): 10'-5"

TO ALL DOCUMENT HOLDERS:

Subject: WCWSD RARWTP Membrane Softening Upgrades

AECOM Job No.: 60551697

Enclosed herewith is a copy of Addendum No. 2 covering the subject project.

Please retain this with your Documents.

Sincerely,

AECOM

Matthew Noelker, P.E.

Attachments:

Pre-Bid Meeting Minutes

Specifications:

1. Section 09 9673 Coating Systems for Chemical Feed Areas
2. Section 40 2319.01 Pipe Supports

Drawings

1. Sheet G-01
2. Sheet GP-06
3. Sheet GP-09
4. Sheet GP-16
5. Sheet GP-17
6. Sheet 1P-03
7. Sheet 1P-05
8. Sheet 1P-08
9. Sheet 1P-10
10. Sheet 1P-13
11. Sheet 1P-16
12. Sheet 1P-18
13. Sheet 1P-19
14. Sheet 1P-20
15. Sheet 4P-01
16. Sheet PD-01

ADDENDUM TO THE
BIDDING DOCUMENTS
FOR:
WCWSD RARWTP Membrane Softening Upgrades

1.1 GENERAL

A. This Addendum covers changes to the Documents and in closing the Contract will become a part thereof. Each Bidder shall include these items to the extent they affect his Bid.

B. These items modify only the portion of the Documents specifically noted. All other wording and Drawings remain in effect.

1.2 CLARIFICATIONS

A. The following is a list of clarifications regarding project documents. These clarifications include questions received during the advertisement period:

C: No plan holder's list is being maintained for this project. An attendance sheet from the pre-bid meeting is attached as part of this addendum.

C: The time of bid opening will be postponed to 2:00 p.m. still on May 28, 2020 – refer to the revised 00 1113 advertisement for bids and resolution as part of this addendum.

C: The NF supplier has not been selected at this point and will be issued in a following addendum.

C: Any substitute products meeting the specification requirements will be reviewed during the shop drawing process as an "Or Equal" to the specified manufacturer.

C: The valve schedule will be issued as an attachment to addendum 3 as an xls.

C: The buried piping schedule is located on Sheet C-01.

C: The existing UV unit is the TrojanUV Swift 24.

C: Valve CK-2100 is to be replaced with a 316 SST insect screen – refer to revised drawings and valve schedule.

C: All piping hardware shall be as identified in 40 0513 paragraph 2.2.B and 40 0523 paragraph 2.2.C.

Q: What is the size for valve BF-2101?

A: This is a 24" valve—refer to revised drawings and valve schedule.

Q: Is there a minimum distance the flange or MJ bell needs to be away from the face of the wall regarding the break tank interconnect?

A: The section of the wall pipe for the break tank interconnect that is on the side of valve BF-2101 must extend 8" away from the wall, refer to revised sheet 1P-05. The section of wall pipe that extends away from the wall can be plain end, and flush with the wall.

Q: The break tank pump suction elbows as shown on 1P-05 and 1P-16 appear to be fabricated fittings, what are these fittings to be?

A: These should be ductile iron flare fittings—refer to revised drawings.

Q: For the 48" break tank overflow piping the submerged elbow appears to be a fabricated fitting, is this fitting to be ductile iron?

A: This should be a ductile iron flare fitting—refer to revised drawings.

Q: Where is the specification description for the two flanged rubber expansion joints at the Break Tank Pumps?

A: Expansion joints are covered under 40 0523 paragraph 2.9.H.

Q: What piping connections will be used on the NF skids?

A: Piping connections on the NF skids shall be flanged. Contractor to provide a grooved coupling or a grooved flanged adaptor to pass the piping from the basement through the finished floor. Contractor to provide grooved flange adaptors to connect to the NF skids.

Q: What pipe material is required for the Cartridge Filter Drains and Air Release?

A: Cartridge filter drains and air release connections are to be stainless steel, refer to modified piping schedule attached to this addendum.

Q: What are the sizes for the branch connections for the future filter skid units.

A: The blind flanges for the future skids are to be 10".

Q: Are the future pump cans to have covers over the opening on the top or the inlet flange connection?

A: The contractor is to provide a cover, inlet blind flange, hardware, and gaskets for cans—refer to revised drawings.

Q: Should pipe sleeves be provided for the four future filter skid units?

A: The Contractor is to provide pipe sleeves for all finished floor penetrations for future skids.

Q: What are the pipe material requirements for the DGE pipe?

A: DGE piping shall be ductile iron, refer to revised piping schedule.

Q: What are the piping material requirements for the analyzers and sample taps?

A: Sample taps and analytical instrumentation piping are to be stainless steel. Refer to the revised piping schedule.

Q: Is a clean-out required for the NFC line at the cascade aerator?

A: A clean-out is required, please refer to revised drawing 4P-01.

Q: Please clarify what the storm drainpipe penetration at the break tank overflow sump location is.

A: The WP-03 callout for both connections have been removed, please refer to revised drawings. Provide a boot connection with a corrugate pipe adaptor, please refer to the paragraph added to section 33 4413, Drainage Structures, Part 2.3 Resilient Connectors.

Q: What is meant by the "MJxMJ adapter" note used for the 36"BLW connection to the existing 30" WM?

A: "MJxMJ Adapter" is meant to be what is needed to connect a mechanical joint bell directly to another mechanical joint bell. The bolt through mechanical joint restraint by In Fact is an example that can be used. Another example is the MJxMJ Adapter by Star Pipe Products.

Q: For valve BF-5201 what are to be the END and SPEC notes as shown as empty cells on the valve schedule?

A: For valve BF-5201 provide mechanical joint ends. Refer to the revised valve schedule.

Q: For BF-5200 there are callouts for dismantling joints on either side of the new valve on an existing 30" WM line, should there still need to be flange by MJ adapters to connect to the existing watermain line? Please review and clarify this valve, its end connections, and specifications.

A: Conform to the "BFV-AWWA" specification (section 40 0523, Part 2.3.A). Provide a mechanical joint butterfly valve for BF-5200. Provide a MJ sleeve and MJ x MJ Adapter as needed to facilitate installation into the existing pipe. The callout on C-18 has been revised, removing callouts for dismantling joints.

Q: What is the depth of the existing 30" waterline that BF-5200 is to be installed on?

A: According to record drawings, the centerline elevation of the 30" pipe is approximately 755'. The ground elevation at the valve is approximately 766'. Field verification of the depth of the existing pipe will be required.

Q: For buried valve end connections is the intention to have flanged butterfly valves installed in the buried yard piping?

A: Provide mechanical joints for buried valves. This includes BF-2000, BF-2001, BF-2002, BF-5200, BF-5201. Refer to the revised valve schedule.

Q: What are the details/specifications for deep buried valves and valve boxes, what will be used for the valve box extension?

A: Refer to paragraph I. Appurtenances for Buried Metallic Valves" that was added to section 40 0523, Part 2.9. For valve boxes where a length longer than 5 ft is required, provide PC 250 (or thicker) cast iron or ductile iron pipe extensions.

Q: How is PI-4015 to be installed?

A: Provide an 8" grooved cross with a socket end reducer for PI 4015 – refer to revised drawings.

Q: For ductile iron piping in the yard or buried, what is the required thickness class?

A: The minimum thicknesses of the buried ductile iron piping shall be per the buried piping schedule on C-01, and thus may be thinner than thickness class 53. This applies only to the buried ductile iron.

Q: For HVAC controls, is there a requirement to tie into an existing building control system for HVAC? What is the current controls system?

A: There is no existing building control system/building automation system to tie into. The HVAC controls associated with the new Membrane Softening building will be electrical and/or DDC stand-a-lone controls as specified in Sections 23 0933 – Automatic Temperature Control Systems and 23 0993 – Automatic Control Sequences. There is no current HVAC Control manufacturer under contract.

1.3 PROJECT MANUAL

A. Section 00 1113 Advertisement for Bids
   1. Paragraph 1 – Replace "11:00 AM" with "2:00 PM".
   2. Resolution – Replace "11:00 a.m." with "2:00 p.m.".

B. Section 09 9600 High Performance Coatings
   1. Paragraph 2.3 – Add the following text to read:
      a. "F. Ferrous Metals, Interior or Exterior, Submerged or Intermittently Submerged in Potable Water:
         1. Surface Preparation: SSPC-SP10 Near White Blast
         2. Shop Primer:
            a. Tnemec N140 Pota Pox Plus @ 3.0 – 5.0 DFT
            b. Carboline Carboguard 61 @ 3.0 – 5.0 DFT
            c. Sherwin Williams Macropoxy 646PW @ 3.0 – 5.0 DFT
         3. Field Preparation: SSPC-SP10 Near White Blast
         4. Field Spot Prime:
            a. Tnemec N140 Pota Pox Plus @ 3.0 – 5.0 DFT
            b. Carboline Carboguard 61 @ 3.0 – 5.0 DFT
            c. Sherwin Williams Macropoxy 646PW @ 3.0 – 5.0 DFT
         5. Stripe Coat:
            a. Tnemec N140 Pota Pox Plus

b. Carboline Carboguard 61
c. Sherwin Williams Macropoxy 646PW

6. Intermediate:
   a. Tnemec N140 Pota Pox Plus @ 4.0 - 6.0 DFT
   b. Carboline Carboguard 61 @ 4.0 - 6.0 DFT
   c. Sherwin Williams Macropoxy 646PW @ 4.0 – 6.0 DFT
7. Finish:
   a. Tnemec N140 Pota Pox Plus @ 4.0 - 6.0 DFT
   b. Carboline Carboguard 61 @ 4.0 - 6.0 DFT
   c. Sherwin Williams Macropoxy 646PW @ 4.0 – 6.0 DFT
8. Total DFT: 11.0 – 17.0 mils

2. Replace "Carboguard 60" coatings with "Carboguard 890". Sub-paragraphs where this occurs include 2.3.A.2.b., 2.3.A.4.b., 2.3.A.5.b., 2.3.D.2.b., 2.3.D.4.b., 2.3.E.5.b., 2.4.A.4.b., 2.4.A.5.b., 2.4.A.5.b., 2.4.A.6.b., 2.4.B.4.b., 2.4.B.5.b., 2.5.A.2.b., 2.5.A.4.b., 2.4.A.5.b., 2.4.B.2.b., 2.4.B.4.b., 2.4.B.5.b., 2.6.A.3.,b., 2.6.A.4.b., 2.6.B.4.b., 2.6.C.3.b, 2.6.C.4.b., 2.7.A.2.b., 2.7.A.3.b., 2.7.D.3.b., 2.7.D.4.b., and 2.8.A.3.b.
3. Paragraph 2.8.A.2.b – replace "Carboguard 60" with "Sanitile 120"
4. Paragraph 2.11.A.2.b. – replace "3358" with "3359DMT"
5. Paragraph 2.11.A.3.b. – replace "3358" with "3359DMT"

C. Section 09 9673 Coating Systems for Chemical Feed Areas
   1. Replace this section in its entirety with the revised Section 09 9673 included in this addendum.

D. Section 26 2200 Transformers
   1. Paragraph 2.2.A – Delete "b. General Electric Company."

E. Section 26 2413 Switchboards
   1. Paragraph 2.2.A – Modify the following text to read:
      a. "2. Square D Company."
      b. "3. Or approved equal."

F. Section 26 2416 Panelboards
   1. Paragraph 2.2 A. – Modify the following text to read:
      a. "2. Square D Company."
      b. "3. Or approved equal."

G. Section 26 2419 Motor Control Centers
   1. Paragraph 2.1.A – add the following text:
      a. "17. Provide ethernet switches and internal ethernet cabling in MCCs as shown on the Drawings. Ethernet switches shall be as specified in Division 40. Ethernet cabling shall be as specified in Division 26."
   2. Paragraph 2.2.A – Modify the following text to read:
      a. "2. Eaton Corporation."
   3. Paragraph 2.2.A – Delete the following text:
      a. "3. Square D."
      b. "4. Or approved equal."

H. Section 26 2913 Motor Controllers
   1. Paragraph 2.7.A – Modify the following text to read:

a. "2. Eaton Corporation."

2. Paragraph 2.7.A – Delete the following text:
   a. "3. Square D."

I. Section 33 4413 Drainage Structures
   1. Part 2 – Modify the following text to read:
      "2.3 RESILIENT CONNECTOR:
         A. Stom pipe to drainage structures on all storm sewers shall be flexible and watertight. Sewer pipe shall be sealed in the manhole section pipe openings with a resilient connector meeting the requirements of ASTM C 923. The resilient connector shall be manufactured by:
            1. Trelleborg Pipe Seals
            2. Press-Seal Corporation
            3. A-Lok Producs Inc.
            4. Or equal"

J. Section 40 0513
   1. Paragraph 2.2.B.1 – Modify the following text to read:
      a. "e. MCS piping: 316 SST"
      b. "f. Chemical Feed Piping: Refer to Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances".
   2. Paragraph 2.2.E.7.c – Revise to read as follows:
      a. "Provide shop fabricated groove by flange adapter fittings."

K. Section 40 0523 Process Valves, Gates, and Accessories
   1. Paragraph 2.2.C – Modify the following text to read:
      a. "8. MCS piping: 316 SST"
      b. "9. Chemical Feed Piping: Refer to Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances".
   2. Paragraph 2.3.N – Revise to read as follows:
      a. "Check Valve (CV-Thermoplastic Ball)".
   3. Part 2 – Products, add the following text as section 2.10
      a. "2.10 ELECTRIC ACTUATORS (BUTTERFLY/BALL VALVES, CHEMICAL SERVICE)
         1. General: Bidirectional (reversing type) motor, with permanently lubricated gear train.
         2. Motor: Low current, reversing DC motor.
         3. Multi-voltage: 85-265 VAC single-phase, 24 VDC.
         4. Overload protection: Motor cuts out at 2 amps.
         5. Gear Train: Permanently lubricated solid gearing.
         6. Enclosure: Combination type NEMA 4X and NEMA 6 with captive cover screws. Thermally bonded powder coated finish.
         7. LEDs (2): Open/close LED position indication.
         8. Manual Override: Push down override button and use provided lever to manually position the valve in the event of power failure.
         9. Electrical Connections: Sealed cable gland with 1.2M flying leads.
         10. Limit Switches: Two (2) end of travel switches and two (2) dry contact switches.
         11. Space Heater: Standard Equipment.
         12. Manufacture/Model: Asahi/Series 17. "

4. Paragraph 2.9.G.1.c – Delete this paragraph.
5. Paragraph 2.9.F.1.c.3 – Modify the following text to read:
    a. "All stem brackets and stem guides shall be 304 SST."
6. Part 2 – Products, add the following text as section 2.9.I
    a. "I. APPURTENANCES FOR BURIED METALLIC VALVES
        1. Wrench Nuts:
            a. Provide wrench nuts on buried valves of nominal two-inch size, in accordance with AWWA C500.
            b. Arrow indicating direction of opening the valve shall be cast on the nut along with the word "OPEN".
            c. Material: Ductile iron or cast-iron.
            d. Secure nut to stem by mechanical means.
        2. Extension Stems for Non-Rising Stem Gate Valves and Quarter-turn Buried Valves:
            a. Provide extension stems to bring operating nut to six inches below valve box cover.
            b. Materials of Stems and Stem Couplings: Type 316 stainless steel.
            c. Maximum Slenderness Ratio (L/R): 100
            d. Provide top nut and bottom coupling of ductile iron or cast-iron with pins and set screws of Type 316 stainless steel.
        3. Valve Boxes:
            a. Valve boxes shall be as indicated and as required.
            b. Type: Heavy-duty, suitable for highway loading, two-piece telescopic, and adjustable. Lower section shall enclose valve operating nut and stuffing box and rest on valve bonnet.
            c. Material: Cast-iron or ductile iron.
            d. Coating: Two coats of asphalt varnish conforming to FS TT-C-494.
            e. Marking: As required for service."

L. Section 40 2319.01 Pipe Supports
    1. Replace this section in its entirety with the revised Section 40 2319.01 included in this addendum.

M. Section 40 9000 Plant Instrumentation and Control System General Requirements
    1. Paragraph 1.1.B – Delete the entire last sentence starting with "Unit process logic residing…"
    2. Paragraph 1.6.B.5 – Modify the following text to read:
        a. "d. Rawdon Myers, Inc. of Ohio"

N. Section 40 9100ATT Primary Sensors and Field Instruments (Attachment)
    1. Change all text as follows under the PROCESS DESCRIPTION column:
        a. From "CAUSTIC SODA" to "SODIUM HYDROXIDE"
        b. From "ORTHOPHOSPHATE" to "CORROSION INHIBITOR"

O. Section 40 9443 Plant Control System
    1. Paragraph 2.1 B.1 – Modify the following text to read:
        a. "b. Color TFT LCD"
        b. "c. 18-bit color graphics"
        c. "h. NEMA 4X"
        d. "j. 512 MB RAM and 512 MB user storage"

2. Paragraph 2.1 B.2 – Modify the following text to read:
    a. "a. Allen-Bradley, PanelView Plus 7 Performance"

P. Section 40 9443ATT Plant Control System (Attachment)
1. PLC Designation CFB010 – Change all text as follows under the MODULE/POINT DESCRIPTION column:
    a. From "HYPO" to "SODIUM HYPOCHLORITE"

2. PLC Designation HSB010 – Modify the rows as follows:
    a. Delete the row with the MODULE/POINT DESCRIPTION as "HIGH SERVICE PUMP 5 HIGH VIBRATION".
    b. Add a row with the following text across columns from left to right, "HSB010, AI, (blank), (blank), SPARE, HIGH SERVICE PUMP 5 VIBRATION SENSOR 1".
    c. Add a row with the following text across columns from left to right, "HSB010, AI, (blank), (blank), SPARE, HIGH SERVICE PUMP 5 VIBRATION SENSOR 2".
    d. Add a row with the following text across columns from left to right, "HSB010, RTD, (blank), (blank), SPARE, HIGH SERVICE PUMP 5 MOTOR BEARING TEMP 1".
    e. Add a row with the following text across columns from left to right, "HSB010, RTD, (blank), (blank), SPARE, HIGH SERVICE PUMP 5 MOTOR BEARING TEMP 2".

3. PLC Designation NFB010 – Change all text as follows under the MODULE/POINT DESCRIPTION column:
    a. From "PHOS" to "CORROSION INHIBITOR"
    b. From "CAUSTIC SODA" to "SODIUM HYDROXIDE"

Q. Section 43 2100.02 Vertical Turbine Pumps and Appurtenances
1. RARWTP PUMP SCHEDULE – under Part B. High Service Pumps:
    a. Replace "17. Can Diameter: 20-inch" with "17. Can Diameter: 30-inch"

R. Section 43 2100.01 End Suction Centrifugal Pumps
1. Paragraph 2.2.A – Modify the following text to read:
    a. "3. Peerless"

S. Section 43 2121 Chemical Transfer Pumps
1. Paragraph 2.1.E.1 – replace "KM" with "K+"

1.4 DRAWINGS

A. Sheet PD-01
1. This sheet is being revised and Reissued as an attachment to this addendum.

B. Sheet PD-02
1. Replace the following text from detail 2, "drill and tap carrier pipe for quill" with "refer to pressure gauge details for pipe tapping method."
2. This sheet is not being Reissued as part of this addendum

C. Sheet C-16

1. Remove downspout callout arrow that points to the inside corner of the NF building. There are to be two downspouts, refer to callouts on C-24.

D. Sheet C-18
   1. In plan view, replace the text that reads “DISMANTLING JOINT” with “MJ SLEEVE AS NEEDED.”
   2. This sheet is not being Reissued as part of this addendum

E. Sheet C-24
   1. In plan view, add the following callout regarding the connection of the 36” STM-1 piping to the break tank overflow sump: “PROVIDE RESILIENT CONNECTOR (PER SECTION 33 4413) FOR CONNECTION TO BREAK TANK OVERFLOW SUMP”
   2. This sheet is not being Reissued as part of this addendum.

F. Sheet 3P-01
   1. In section A, remove the “2’-5”” dimension on the pump can.
   2. This sheet is not being Reissued as part of this addendum.

G. Sheet G-01
   1. This sheet is being revised and Reissued as an attachment to this addendum.

H. Sheet GP-06
   1. This sheet is being revised and Reissued as an attachment to this addendum.

I. Sheet GP-09
   1. This sheet is being revised and Reissued as an attachment to this addendum.

J. Sheet GP-10
   1. Delete the “42” TEE W/ PLUG FOR FUTURE FILTER TIE-IN”.
   2. This sheet is not being Reissued as part of this addendum.

K. Sheet GP-16
   1. This sheet is being revised and Reissued as an attachment to this addendum.

L. Sheet GP-17
   1. This sheet is being revised and Reissued as an attachment to this addendum.

M. Sheet 1P-03
   1. This sheet is being revised and Reissued as an attachment to this addendum.

N. Sheet 1P-05
   1. This sheet is being revised and Reissued as an attachment to this addendum.

O. Sheet 1P-08
   1. This sheet is being revised and Reissued as an attachment to this addendum.

P. Sheet 1P-10
   1. This sheet is being revised and Reissued as an attachment to this addendum

Q. Sheet 1P-13

1. This sheet is being revised and Reissued as an attachment to this addendum.

R. Sheet 1P-16
   1. This sheet is being revised and Reissued as an attachment to this addendum.

S. Sheet 1P-18
   1. This sheet is being revised and Reissued as an attachment to this addendum.

T. Sheet 1P-20
   1. This sheet is being revised and Reissued as an attachment to this addendum.

U. Sheet 4P-01
   1. This sheet is being revised and Reissued as an attachment to this addendum.

V. Sheet E-06
   1. Add coded note 16 symbol adjacent to the Membrane Cleaning System Control Panel. Under Coded Note 15, add coded note 16 text that reads, “PROVIDE CONTROL, ANALOG, AND POWER CONDUIT AND WIRES FROM THE MEMBRANE CLEANING SYSTEM CONTROL PANEL TO THE MEMBRANE CLEANING SYSTEM COMPONENTS. CONTROL CONDUITS SHALL BE 3/4" WITH (2)#14+(1)#14G FOR EACH CONTROL DEVICE. ANALOG CONDUITS SHALL BE 1" WITH (1) STP FOR EACH ANALOG DEVICE. POWER CONDUITS SHALL BE 1.25" WITH (3)#4+(1)#8G VFD CABLES FOR EACH PUMP, 2" CONDUIT WITH (3)#1/0+(1)#6G FOR THE 120KW HEATER, AND 1.5" CONDUIT WITH (3)#1+(1)#6G FOR THE 75KW HEATER."
   2. This sheet is not being Reissued as part of this addendum.

END OF ADDENDUM NO. 2
(SEE ENCLOSURES)

AECOM

Meeting Minutes

This meeting was conducted to discuss bidding of RARWTP Membrane Softening Upgrades Project. A sign-in sheet was distributed at the beginning of the meeting and is attached to these minutes.

1) Questions discussed at the pre-bid meeting included:
   a) The Membrane Equipment Procurement will include all terms and conditions for the Contract between the Buyer (Contractor) and the Seller (OEM). The OEM's pricing will include start-up services. This information will be included via addendum once obtained by the Engineer (week of May 18, 2020).
   b) Approval for funding is scheduled to occur on June 25, 2020 at the OWDA board meeting. NTP will be issued shortly thereafter, as soon as July 1, 2020.
   c) Wage rate requirements will be clarified via addendum.
   d) The Ohio EPA Plan Approval has officially been obtained.
2) Bid Opening will be May 28, 2020 at 2:00 pm at The Office of the Warren County Commissioners, 406 Justice Drive, Lebanon, Ohio 45036. The bid opening date cannot be postponed due to the Ohio EPA funding schedule, but the time of day of the bid opening has been pushed back to later in the day. Any change to the bid opening time and clarification of how to drop the bids off will be addressed via addendum.
3) Funding – Ohio EPA WSRLA. The County indicated that some County funds will be used as well.
4) Attachments:
   a) Sign-in Sheet
   b) Agenda

The meeting adjourned at approximately 11:15 A.M.

END OF MINUTES

Warren County, Ohio
RARWTP Membrane Softening Upgrades
Pre-Bid Agenda
May 12, 2020 @ 10:00 A.M.

AGENDA

1) Attendance sheet: please print name, company, email address, and phone number
2) Introductions
3) Note that statements made in this meeting that in any way modify what is contained in the Issued for Bidding documents are not to be considered as a change to those documents unless issued in an Addendum prior to the bid.
4) There will be an opportunity to ask questions at the end.
5) All technical questions must be submitted in writing to: miranda.scheitlin@aecom.com
   a) Questions requiring clarification or changes to the bid documents will be addressed via addenda.
   b) Any verbal or email clarifications made outside of an addendum will not be considered as changes to the bid documents unless officially addressed via addenda.
6) Bid Opening is May 28, 2020 at 11:00 am at The Office of the Warren County Commissioners, 406 Justice Drive, Lebanon, Ohio 45036.
7) Bid Documents Required:
   a. Section 00 2113, “Instructions to Bidders”. (for information only)
   b. Section 00 4113, “Bid Form”.
   c. Section 00 4313, “Bid Security Form”.
   d. Section 00 4325, “Substitution Request Form”. (optional)
   e. Section 00 4333, “Proposed Products Form”.
   f. Section 00 4336, “Proposed Subcontractor’s Form”.
   g. Section 00 4513, “Bidder’s Qualifications”.
   h. Section 00 4515 “OEPA WSRLA Program Requirements”
      i. Contractor Equal Employment Opportunity (EEO) Certification
      ii. Certification Regarding Debarment, Suspension and Other responsibility Matters.
      iii. DBE Forms 1A and 1B
      iv. Certification Regarding Debarment, Suspension, & Other Responsibility Matters
      v. American Iron & Steel Acknowledgement Form
   i. Section 00 4519, “Non-Collusion Affidavit”.
   j. Section 00 4529, “Personal Property Tax Disclosure Affidavit”.
   k. Section 00 4539, “Finding’s for Recovery Affidavit”.
   l. Surety’s Power of Attorney.
   m. Certification of Authorization to do business In Ohio (if applicable)
8) The County will review bids and award the project within 90 days. The County intends to secure funding at the OWDA board meeting on June 25, 2020.
9) Engineer’s Estimate
   a) $26,856,000

10) Allowances (refer to section 01 2100, "Allowances")

a.	Tools and Maintenance Equipment:	$20,000
b.	Office Furniture:	$20,000
c.	Materials Testing:	$60,000
d.	Local Utility Company:	$10,000
e.	Trailer Mounted Valve Operator:	$15,000
f.	Security System:	$70,000
g.	NFC Cleanouts and CCTV:	$45,000
h.	Lab Equipment:	$5,000
i.	SCADA:	$20,000

11) Alternates

a. No alternates.

12) Membrane Equipment

a) Membrane Equipment manufacturer is currently being selected by the Owner. Contractors will be notified of selected manufacturer and manufacturer's pricing via addendum. Owner is not purchasing equipment on behalf of the Contractor.

13) Contract Award

a. Contract award will be determined by base bid plus allowances.

14) Funding – Ohio EPA WSRLA

15) Time of completion for the project:

a.	Substantial Completion:	548 consecutive calendar days.
b.	Final Completion:	640 consecutive calendar days.

16) Liquidated Damages

a. Damage compensation

i.	Substantial Completion:	$500 per day
ii.	Final Completion:	$500 per day

17) Wage Rates

a. Included in Section 00 7343. Wage rates for this project Davis-Bacon for Warren County, Ohio.

18) Permit Status

a. Ohio EPA Plan Approval is to be obtained by the Owner (awaiting final permit approval)
b. Building Permit is to be obtained by the Owner (conditional approval received)
c. NPDES Permit has been obtained by the owner

19) Minutes from this Pre-Bid will be issued in an Addenda.

20) Questions and Answers

21) Further Questions:

a. Technical and Bidding Questions – Submit all questions, in writing, prior to close of business on Thursday May 21, 2020 to be sure a proper response can be made.

22) Site walk-thru.

ATTENDANCE SHEET
RARWTP Membrane Softening Upgrades

AECOM

Date: May 12, 2020	**Location:** 6193 Striker Road, Hamilton Township, Ohio		
Time: 10:00 AM	**Meeting Topic:** Pre-Bid Meeting		
Name (Print "Clearly" or include your business card)	**Organization**	**Street Address** (include your street address, city and zip code) **Email Address**	**Phone Number** **Fax Number**
Ric Grimmer	Solid Platforms	Ric.Grimmer@solidplatforms.com	812 318 8424
Tyler Holden	Rack + Ball over Excavating	11321 Paddys Run Rd. Hamilton, OH 45013 holden.tyler@gmail.com	513-738-7000 513-738-2777
Kate Holden	KT Supply (WBE)	1073 B Oregonia Rd, Lebanon, OH 45036 KtesupplyLtd@gmail.com	513-846-0257
Dan Harlander	Arcadis	4665 Cornell Road Suite 200 Cincinnati, OH 45241	513-985-8045
Andrew Boring	Siemens	1310 Kemper meadow Dr. Cincinnati, OH 45240 andrew.boring@siemens.com	513 319 9529
MARTY DAVIDSON	BL ANDERSON	9897 EAGLE RIDGE CT, WEST CHESTER MARTY@BLANDERSON.COM	513-609-1955
Peter Kube	Arcadis	Peter.Kube@arcadis.com	513-985-8039
Rick Buckler	Glenwood Elec.	rob@glenwoodelectric.com 12250 Chandler, Walton, KY 41094	513-312-1973

AECOM

ATTENDANCE SHEET
RARWTP Membrane Softening Upgrades

Date: May 12, 2020	**Location:** 6193 Striker Road, Hamilton Township, Ohio		
Time: 10:00 AM	**Meeting Topic:** Pre-Bid Meeting		
Name (Print "Clearly" or include your business card)	**Organization**	**Street Address** (include your street address, city and zip code) **Email Address**	**Phone Number** **Fax Number**
Matt Noelker	AECOM	277 W. Nationwide Blvd. matthew.noelker@aecom.com	614-600-5980
Brian Bennett	AECOM		
Mary Schirmer	Dugan & Meyers	mschirmer@dugan-meyers.com	513-646-4972
Josh Lanoux	Dugan + Meyers	JLANOUX@DUGAN-MEYERS.COM	513-903-7349
Dave Warner	Shook Construct	estimating@shookconstruction.com	937-510-3880
Justin Crowthers	ESI	Justin.Crowthers@ESIElectrical.com	937.313 4604
Mike Webb	ESI	mike.webb@ESIELECTRICAL.com	513 615 1920
JAY PIPER	GENERATOR SYSTEMS	JPIPER@GENERATORSYSTEMS.COM	513-349-4630
Matt Galbreath	Driekost Piping HVAC & Plumbing	MGalbreath@C-Driekost.com	513 728 5606
Ben Call Brad Miller Shane Paxton Rob Birkenhauer	Building Crafts	2 Rosewood Drive, Wilder, KY 41076 bcall@buildingcrafts.com	859-781-9500

AECOM

ATTENDANCE SHEET
RARWTP Membrane Softening Upgrades

Date: May 12, 2020	**Location:** 6193 Striker Road, Hamilton Township, Ohio		
Time: 10:00 AM	**Meeting Topic:** Pre-Bid Meeting		
Name (Print "Clearly" or include your business card)	**Organization**	**Street Address** (include your street address, city and zip code) **Email Address**	**Phone Number** **Fax Number**
JEFF ALBERS	KOKOSING	 JPAC KOKOSING, BIZ	513-200-2647 NA
CHRIS DAUGHERTY	KOKOSING	 CCD C KOKOSING, BIZ	614-989-2486
miranda Scheitlin	AECOM	 miranda.Scheitlin@AECOM.com	 614-606-5804
JEFF Besting	Lake Erie Electric	 jbeiting@lakeerieelectric.com	 937743-1220

THIS SECTION IS BEING REVISED AND REISSED AS PART OF ADD #2

SECTION 09 9673

COATING SYSTEMS FOR CHEMICAL FEED AREAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications sections apply to this Section.

1.2 DESCRIPTION OF WORK

A. Section includes coating systems for secondary containment for chemical feed storage areas in wastewater facilities, including below-grade concrete chemical containment trenches above-grade containment sumps and walls. **All chemical rooms are separated and different coatings may be supplied for different rooms to match compatibility with the store chemical. The stored chemicals are as follows:**

1. 12.5% Sodium Hypochlorite
2. 38% Sodium Bisulfite
3. 100% Antiscalant
4. 50% Sodium Hydroxide
5. 23% Fluoride
6. 28.5% Orthophosphate

B. The following areas within each chemical feed area shall be coated:
1. Floors
2. Sumps
3. Walls (up to top of secondary containment area)

1.3 DELIVERY, STORAGE, AND HANDLING

A. Comply with the requirements specified in Division 01, Section “Product Requirements”.

B. Material shall be delivered to project site in manufacturer's original unopened containers.

C. Material shall be stored indoors, protected from damage, moisture, direct sunlight, and temperatures below 40 deg F or above 90 deg F.

1.4 ENVIRONMENTAL CONDITIONS

A. Surface and surrounding air temperatures must exceed 55 deg F but must be less than 90 deg F with materials at not less than 70 deg F during application. Do not apply if the relative humidity is more than 90% or the surface temperature is less than 5% above the dew point of the air in the working area.

1.5 QUALIFICATIONS OF APPLICATOR

A. Installation shall be performed by an applicator having satisfactory experience in the application of these or similar materials or with on-site consultation by a qualified field service representative from the manufacturer.

1.6 SUBMITTALS

A. Submittals shall follow requirements of Division 01, Section “Submittal Procedures”.

B. Prior to commencing work, submit to owner, manufacturer's technical information and installation details describing materials to be used.

C. Owner, contractor, and manufacturer shall review and mutually agree upon color, grade, and final texture of coating system before starting installation. The acceptance of a sample will constitute the job standard by which installation will proceed.

D. The coating supplier shall submit a written certification that the proposed coating system supplied for individual chemical rooms are compatible with the chemical being stored in that room.

PART 2 - PRODUCTS

2.1 MATERIALS (OPTION #1)

A. Surfacer: Series 218 Mortar Clad epoxy modified cement.

B. Primer: Series 201 Epoxoprime, penetrating polyamine cured epoxy primer.

C. Reinforced Coating: Series 275 Novolac Stranlok fiber reinforced coating.

D. Glaze Coat: Series 282 Tneme-Glaze, pigmented epoxy novolac.

E. Manufacturer
1. Tnemec Company, Incorporated
   3974-A Brown Park Dr.
   Hilliard , Ohio 43026-1168
   1-800-890-7580
2. Carboline Company.
3. Sherwin Williams; Industrial and Marine Coatings (S-W).
4. PolySpec (Thiokol).
5. Sprayroq

2.2 MATERIALS (OPTION #2)

A. Primer: Dudick Inc, Primer 67

B. Resurfacer: Scratch Coat 300

C. Reinforced Coating: **Protecto-Flex 800 or 805, as determined by the manufacturer for specific chemicals. Provide fiberglass mat reinforced with 100 mil crack protection guarantee.** ~~Protecto-Flex 100XT, Fiberglass mat reinforced with 100 mil crack protection guarantee~~.

D. Manufacturer
1. Dudick
1818 Miller Pkwy
Streetsboro, Ohio 44241
1-800-322-1970

2.3 MATERIALS (OPTION #3)

A. Restructuring: Semstone 145 or 800 Series Primer System (selected by manufacturer)

B. Primer: Semstone 140 or 800 Series Primer (selected by manufacturer)

C. Reinforced Coating: Aggregate filled reinforcing coating, Semstone Scrim Cloth, Smestone 145 or 800 series (selected by manufacturer)

D. Manufacturer
1. Carboline Company
2150 Schuetz Rd
St Louis, MO 63146

PART 3 - EXECUTION

3.1 PREPARATION

A. Allow new concrete to cure for 28 days. Verify dryness by testing for moisture by using calcium chloride discs and with the "plastic film tape-down test". (Reference ASTM D 4263)

B. Preparation (Materials Option #1)
1. Degrease and clean to remove all surface contaminants as needed. Mechanically abrade all concrete by means of self-contained, blasting equipment or equal, to remove all laitance and surface contaminants and provide a minimum profile similar to 40-60 grit sandpaper. (Reference ASTM D 4259 and ICRI CSP 4-5)

C. Preparation (Materials Option #2)
1. Concrete must be prepared mechanically to remove surface laitance. Oils, grease or other contaminant must be removed prior to surface preparation. Concrete must be free of curing compounds and form release agents. Surface texture should be similar to 40-60 grit sandpaper or the visual standard, CSP-5 from the International Concrete Repair Institute with exposed pea gravel. The prepared surface should have a minimum tensile strength of 250 PSI per ASTM D-4541.

D. Preparation (Materials Option #3)
1. Proper preparation is critical to ensure an adequate bond. The substrate must be dry and free of all wax, grease, oils, fats, soil, loose or foreign materials and laitance. Laitance and unbonded cement particles must be removed by mechanical methods, i.e., abrasive blasting or scarifying. Other contaminants may be removed by scrubbing with a heavy-duty industrial detergent and rinsing with clean water. Concrete should be properly cured for 28 days or reach a compressive strength of 3625 psi prior to coating.

2. Once either of these 2 conditions is met, the moisture levels of the concrete should be measured. Carboline supports and recommends the standards of SSPC-SP13/NACE 6 for moisture levels and curing of concrete. If the moisture is at the appropriate level for the test run (ASTM D2170-Insitu Probe max of 80% RH; ASTM F1869 (Calcium Chloride teste) max of 3#/1000²feet/24hr; or ASTM D4263 (plastic sheet test) – pass/fail), then the coating system can be applied. If one of the cure parameters AND one of the moisture parameters cannot be met. The tests should be repeated at minimum intervals of 3-5 days until successfully tested. Ensure the pH in the range of 7 to 11. The surface must show open pores throughout and have a medium grit sandpaper texture. Prepare surface by mechanical means: Abrasive "Sweep" Blast with a 16-40 mesh angular aggregate or shot blast and provide a profile similar to ICRI CSP 4 – 6.

E. After mechanically abrading, verify that all surfaces are clean, dry, and free of any contaminants, which could adversely affect the adhesion of the flooring system.

3.2 SPECIFICATION FOR WALLS, FLOORS, SUMPS AND TRENCH DRAINS

A. Installation (Materials Option #1)
1. Surfacing: Fill all bugholes, spalled areas and surface imperfections with 218 MortarClad. Concrete block to be filled using Series 130 Envirofill.
2. Cove: Floor and wall transitions are to have a 2-inch cant or radius cove. This will provide a seamless wall to floor transition.
3. Priming: Series 201 Epoxoprime primer shall be mechanically mixed and applied in accordance with manufacturer's printed instructions and applied uniformly at a film thickness of 6.0 to 8.0 dry mils DFT. It should be topcoated after 2 hours and within 16 hours.
4. Fiber Reinforced Coating: Install Series 275 Stranlok by spray application or trowel in a minimum of 2 passes to a total dry film thickness of 40.0 – 60.0 mils DFT.
5. Glaze Coat: Series 282 epoxy novolac glaze coat shall be mechanically mixed in accordance with manufacturer's printed instructions and applied in a single application at a film thickness 8.0 - 12.0 mils DFT.
6. Joints: Active expansion, construction and control joints are to be honored unless determined otherwise by the owner or project engineer. Joints and epoxy floor terminations are to be keyed and shall be sawed through the Coating system and filled with an appropriate Polysulphide flexible sealant.

B. Installation (Materials Option #2)
1. Priming: Dudick Inc Primer 67 shall be mechanically mixed and applied in accordance with manufacturer's printed instructions and applied uniformly at a film thickness of 3.0 to 5.0 dry mils DFT.
2. Resurfacing: Mechanical preparation removes laitance, exposing honeycombs or voids beneath the surface which must be filled with Dudick Inc Scratch-Coat 300.
3. Fiber Reinforced Coating: Protecto-Flex 100XT shall be an epoxy lining consisting of 1/16" trowel applied basecoat, one layer of fiberglass mat reinforcement, and a flake filled epoxy topcoat at 20 mils DFT.
4. Joints: Active expansion, construction and control joints are to be honored unless determined otherwise by the owner or project engineer. Joints and epoxy floor terminations are to be keyed and shall be sawed through the Coating system and filled with an appropriate Polysulphide flexible sealant. Such as Dudick Caulk 149

C. Installation (Materials Option #3)

1. **Priming vertical section/walls: Semstone 800 series primer shall be mechanically mixed and applied in accordance with manufacturer's printed instructions and applied uniformly at a film thickness of 8.0 to 10.0 dry mils DFT.**
2. **Restructuring and cove: Fill all bug holes, spalled areas, and surface imperfections. Prime with Semstone 800 series primer and allow to cure tack free. Blend 1 gallon of mixed Semstone 800 series primer with 1 gallon of an 80-120 mesh silica or Filler #47 and Semstone Thixotrope Part "D". Pour the blended Semstone 800 series primer at the base of the wall and work the material up into the form voids. Apply as a scratch coat and do not add any thickness. Provide a consistent 1" 45°chamfer or radius at the floor to wall juncture. Allow to cure a minimum of 12 hours before proceeding.**
3. **Semstone 870 Vertical System: Blend Semstone 870 with a fine 80-120 mesh Silica or Filler #47 @ a ratio of 1 part Semstone 870 – 1 part fine Silica aggregate by volume. NOTE: use 1 gallon units for vertical surfaces. Add Semstone Thixotrope Part "D" until the mixture hangs on a stir stick. Trowel apply @ 40 mils. Remove trowel marks with odorless mineral spirits on a clean trowel. For Chemical Service, allow to cure 48 hours @ 75ºF prior to putting the area in service. Note: Filler #47 to be used in place of silica to make mortar and for broadcast for Sodium Hypochlorite and Hydrofluosilicic Acid areas.**
4. **Fiber Reinforced Coating System on Horizontal Surfaces: Apply Semstone 870 at 20-25 mil with notched squeegee and medium nap roller. Unroll the scrim cloth evenly and carefully. Embed into the wet basecoat. Overlap seams a minimum of 1-1/2". Insure that all wrinkles and air is removed and that the cloth conforms to the surface. Apply saturant coat of Semstone 870 at 30 mils. Broadcast the 20/40 mesh Silica or Filler #47 evenly and provide a dry beach sand appearance. Allow to cure until the system can support your weight without disrupting the base-coat. Once cured, remove all excess aggregate. Apply Semstone 870 top-coat @ 20 mils with flat squeegee and back-roll with a medium nap roller. Allow to cure a minimum of 48 hours @ 75 ºF prior to puting the area in service.**
5. **Joints: Active expansion, construction and control joints are to be honored unless determined otherwise by the engineer. Joints and epoxy floor terminations are to be keyed and shall be sawed through the Coating system and filled with an appropriate Polysulphide flexible sealant.**

D. Job Standard: Prior to commencing the installation, the contractor shall install, with the owner's approval, a mutually agreed upon test sample to show final color and appearance of the system. This test area shall serve as a job standard for the final installation.

E. Cleanup: Remove waste materials, rubbish, and debris and dispose of them at the owner's direction. Leave work areas in a clean condition.

F. Protection

1. Protect the completed work from water, airborne particles or other surface contaminants until cured for a minimum of 24 hours after application.
2. Protect from traffic, physical abuse, immersion and chemical exposure until the complete system has thoroughly cured for the minimum equivalent of 24 hours at 75°F. For different temperatures, consult the manufacturer's representative about curing times.

3.3 CONTRACT CLOSEOUT

THIS SECTION IS BEING REVISED AND REISSED AS PART OF ADD #2

A. Provide in accordance with Section 01 7700.

END OF SECTION 09 9673

THIS SECTION IS BEING REVISED AND REISSED AS PART OF ADD #2

SECTION 40 2319.01

PIPE SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles.

B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.

C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.

D. Pipe support locations and types for piping 1/2-inch (13 mm) and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports 1/2 inch (13 mm) and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.
   1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.

E. Design and provide all temporary pipe supports required during installation and testing.

1.2 REFERENCES:

A. The American Society of Mechanical Engineers (AMSE):
   1. B31.1: Power Piping.

B. ASTM International (ASTM):
   1. A36: Standard Specification for Carbon Structural Steel
   2. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
   3. A312: Seamless and Welded Austenic Stainless Steel Pipe
   4. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.
   5. A572: Specification for Steel Plate.
   6. E165: Practice for Liquid Penetrant Inspection Method.
   7. E709: Practice for Magnetic Particle Examination.

C. American Welding Society (AWS):
   1. D1.1: Structural Welding

D. Fluid Sealing Association: Technical Handbook.

E. Manufacturers' Standardization Society (MSS):
   1. SP-58: Pipe Hangers and Supports - Materials and Design.
   2. SP-69: Pipe Hangers and Supports - Selection and Application.
   3. SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.
   4. SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

1.3 SUBMITTALS:

A. Submit the following in accordance with Division 01, Section "Submittal Procedures":
   1. Pipe support drawings specified herein and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.
      a. Detailed drawing of the device with dimensions.
      b. A table of applied forces and moments.
      c. A complete bill of materials.
      d. A unique identification and revision level.
      e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified herein.

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      f. Detailed connections to ~~**existing**~~ supporting structure**s along with resulting loads to structure**.
      g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1.
   2. Welding Procedure: Submit description required to illustrate each welding procedure to be performed in the specified work.
   3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.
   4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.
   5. Pipe support manufacturers' qualifications as specified herein.
      a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.
      b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.
   6. Coordination drawings for pipe supports shall include as a minimum the following information.
      a. Coordination drawings shall include all pipe supports covered by specifications.

b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.
c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.
d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4-inch (5 mm) scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-inches (50 mm) or less in diameter that will be field routed need not be shown on coordination drawings.
e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.
f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Engineer. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Engineer shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Engineer for resolution.
g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.
h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.

7. Written notification of any deviations from the requirements of this specification.
8. Support documentation and justification as specified.
9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.
10. Manufacturer's product data and specifications for shop painting.

B. Material Certification:
1. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. A copy of the contract mechanical process, and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for

the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
    a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
    b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.4 QUALITY ASSURANCE:

A. Provide in accordance with Division 01, Section “Quality Control”.

B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.

C. Welder Qualifications:
1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.

D. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

E. Structural Concrete: Conform to the requirements of Section 03 30 00. Concrete strength: 4,000 PSI (28 MPa) unless noted otherwise.

F. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

G. Pipe Support Manufacturer Qualifications:
1. Must possess a written quality assurance program.
2. Have a minimum of 5 years experience in the design and fabrication of pipe supports.
3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.
4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years experience in the design of piping systems and pipe supports.
5. Manufacturers' Standardization Society (MSS) Member.

6. Have a field service technician on staff with at least 5 years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.

H. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Division 01, Section "Product Requirements".

PART 2 - PRODUCTS

2.1 MATERIALS:

A. 316L Stainless Steel Supports: All submerged piping, piping within tanks/wet wells, and outdoor piping shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of 316L SST, unless otherwise indicated.

B. FRP Supports: All piping with chemical feed rooms and all piping carrying chemicals shall be supported with assemblies including framing, hardware, and anchors constructed of FRP, unless otherwise indicated. 316L SST supports are an acceptable alternate.

C. Hot Dipped Galvanized Steel Supports: Unless otherwise indicated, all other pipe support assemblies, including framing, hardware, and anchors, shall be of hot dipped galvanized steel construction.

D. Provide only new material. Previously used and/or scrap material is not acceptable.

E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.

F. Provide sliding Teflon plates. The sliding surfaces shall be a nominal 3/8-inches (10 mm) glass filled Teflon bonded to stainless steel backup plate with a 10 gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Conslide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc. or acceptable equivalent product.
   1. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:
   2. Tensile strength -2,000 psi (14 MPa).
   3. Elongation -225 percent
   4. Specific Gravity -2.17 to 2.22
   5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi (14 MPa).
   6. The compressive creep shall be a minimum of 2 percent at 2,000 psi (14 MPa) and 70 degrees F (21 degrees C).
   7. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer's plant.

THIS SECTION IS BEING REVISED AND REISSED AS PART OF ADD #2

ADD #2

G. Concrete anchor **systems. Comply with the requirements of Seciton 05 0533, Anchor Systems.** ~~**bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.**~~

2.2 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS:

A. Design and provide pipe supports for piping 1/2-inch (13 mm) and larger to include the following loads:
   1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.
   2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.
   3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.
   4. Wind Loadings: Wind loadings.

B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.

C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.

D. Where possible, provide pipe supports, which are the manufacturers' standard products.
   1. Provide pipe supports with individual means of adjustment for alignment.
   2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.
   3. Hanger rods shall be subjected to tension only.
   4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.
   5. Provide concrete inserts capable of supporting the design loads.
   6. Metal framing systems will be acceptable to support piping 2 inch (50 mm) and smaller.
   7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16 gauge (1.5 mm) shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 inch (300 mm) in length.
   8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.
   9. Provide supplementary steel as needed.
   10. Do not support pipes from other pipe, conduits or metal stairs.
   11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.
   12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.
   13. All pipe supports located in fluid flow shall be supplied with double nutting.

E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.

F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

G. For piping 2-inch (50 mm) and smaller provide manufacturer's standard supports and standard spacing guidelines

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~~**H. Pipe supports connected to structural framing and slabs are subject to the following limitations:**~~

~~**1. Less than 100 lb horizontal load per support.**~~

~~**2. Vertical loads not to exceed an average of 100 P.S.F. for slabs, with a maximum vertical load per hanger of 2,500 lbs.**~~

~~**3. Maximum of one pipe support per foot of slab width perpendicular to the span.**~~

~~**4. Piping not supported from floors by metal framing must meet the limitations as specified above.**~~

H. Pipe supports connected to structural framing and slabs are subject to the following requirements and restrictions:

1. Where possible, subject to these requirements, piping shall be supported from above. If supporting from above is not possible due to these requirements, piping may be supported from below.

2. Piping 24-inches and larger shall not be hung directed from the 12-inch floor slab above. Overhead supports for these pipes must coincide with the location of floor beams above or they shall be supported from the foundation mat below.

3. Vertical loads not to exceed an average of 100 P.S.F. for slabs. Piping exceeding these requirements must be supported from the foundation mat below.

4. Piping not supported from floors by metal framing must meet the limitations as specified above.

~~**I. All outside above ground supports shall be Type 316L stainless steel as specified herein.**~~

J. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.

K. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.3 FABRICATION:

A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.

B. Providing welding in accordance with Structural Welding Code.

C. Provide dimensional tolerances as specified in MSS-SP-89.

D. Provide threading and tapping in accordance with MSS-SP-89.

2.4 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Division 09, Section “High Performance Coatings.”

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.

B. Perform welding in accordance with Structural Welding Code:
1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of grove welds for throat opening and for snug positioning for back-up bars.
2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.
3. Magnetic Particle Inspection: Perform in accordance with ASTM E709.
4. Liquid Penetrant Inspection: Perform in accordance with ASTM E165.
5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.
6. Test Locations: As selected by the Engineer.
7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.

C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Division 03, Section “Cast-in-Place Concrete.”

D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.

F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 inch/100 feet (10 mm/10 m), for each 100 degrees F (50 degrees C) change in temperature exceed 1/2-inch (13 mm), provide sliding supports.

I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8-inch (3 mm) thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.

J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.

K. Apply an anti-seize compound to nuts and bolts on all pipe supports.

L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.2 INSTALLATION OF BUILDING ATTACHMENTS:

A. Support piping from structural framing, unless otherwise indicated.

B. Concrete Inserts:
1. Use existing embedded concrete items whenever possible.
2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.3 THRUST ANCHORS AND GUIDES:

A. Thrust Anchors:
1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.
2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.4 PIPE SUPPORTS:

A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.

B. Provide minimum of two pipe supports for each pipe piece.

C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 inch (40 mm) out from face of wall and at least 3 inches (75 mm) below ceiling.

F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.

H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

J. Do not support piping from other piping.

K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

M. All rigid rod hangers shall provide a means of vertical adjustment after erection.

N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.

O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.

P. Hanger spacing shall not exceed the spacing listed below:
   1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.
   2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical,

a support shall be placed immediately adjacent to any change in direction of the piping system.

Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.

R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

S. All threads shall be UNC unless otherwise specified.

T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8-inch (3 mm) fillet weld, 1/2-inch (13 mm) long every 3 inches (75 mm) on center each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.

3.5 INSULATED PIPING:

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where vapor barriers are indicated on water piping, install coated protective shields.

END OF SECTION 40 2319.01

TO ALL DOCUMENT HOLDERS:

Subject: WCWSD RARWTP Membrane Softening Upgrades

AECOM Job No.: 60551697

Enclosed herewith is a copy of Addendum No. 1 covering the subject project.

Please retain this with your Documents.

Sincerely,

AECOM

Matt Noelker

Matthew Noelker, P.E.

ADDENDUM TO THE
BIDDING DOCUMENTS
FOR:
WCWSD RARWTP Membrane Softening Upgrades

1.1 GENERAL

A. This Addendum covers changes to the Documents and in closing the Contract will become a part thereof. Each Bidder shall include these items to the extent they affect his Bid.

B. These items modify only the portion of the Documents specifically noted. All other wording and Drawings remain in effect.

1.2 CLARIFICATIONS

A. The following is a list of clarifications regarding project documents. These clarifications include question received during the advertisement period:

Q: What date is the pre-bid meeting?
A: The pre-bid meeting is scheduled for May 12, 2020 @ 10:00 a.m. at the Richard A. Renneker Water Treatment Plant, 6193 Striker Road, Hamilton Township, Ohio.

1.3 PROJECT MANUAL

A. Section 00 2113 Instruction to Bidders
   1. Part 1.4.G – Revise “May 14” to read “May 12”.

END OF ADDENDUM NO. 1
(SEE ENCLOSURES)

PROJECT MANUAL

WCWSD RARWTP
MEMBRANE SOFTENING UPGRADES

ISSUED FOR BID

April 1, 2020
Project No. 60551697

277 WEST NATIONWIDE BOULEVARD
COLUMBUS, OHIO 43215-2566
Tel 614.464.4500
Fax 614.464.0588

SECTION 00 0101

PROJECT TITLE PAGE

Title and Location of Work:

Warren County Water & Sewer Department (WCWSD)

Richard A. Renneker Water Treatment Plant (RARWTP)
Membrane Softening Upgrades
6193 Striker Road
Maineville, OH 45036

Name and Address of Owner:

Warren County Board of Comissioners
Attn: Chris Wojnicz, P.E., LEED AP
Deputy Sanitary Engineer

406 Justice Drive
Lebanon, OH 45036

Name and Address of Architectural and Engineering Services:

AECOM
277 West Nationwide Boulevard
Columbus, OH 43215-2566
Telephone: 614-464-4500
Fax: 614-464-0588
Emails:
matthew.noelker@aecom.com
miranda.scheitlin@aecom.com

END OF SECTION 00 0101

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SECTION 00 0110

TABLE OF CONTENTS

VOLUME 1

PROCUREMENT AND CONTRACTING DOCUMENTS GROUP

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

SPECIFICATIONS GROUP

General Requirements Subgroup

DIVISION 01 – GENERAL REQUIREMENTS

END OF SECTION 00 0110

BOARD OF COUNTY COMMISSIONERS
WARREN COUNTY, OHIO

406 Justice Drive, Lebanon, Ohio 45036
www.co.warren.oh.us
commissioners@co.warren.oh.us

Telephone (513) 695-1250
Facsimile (513) 695-2054

TOM GROSSMANN
SHANNON JONES
DAVID G. YOUNG

ADVERTISEMENT FOR BIDS

Separate sealed bids will be received by the Clerk of the County Commissioners, Warren County, Ohio, 406 Justice Drive, Lebanon, Ohio 45036, until 11:00 AM, Thursday May 28, 2020, at the Office of the Warren County Commissioners, and then at said time bids will be opened and read aloud for the Richard A. Renneker Water Treatment Plant (RARWTP) Membrane Softening Upgrades Project.

Bid documents including terms, general conditions, supplemental conditions and specifications are available online at the Warren County's Website at
https://www.co.warren.oh.us/Commissioners/Bids/Default.aspx

Questions regarding the technical specifications shall be submitted electronically to the Engineer:
Miranda Scheitlin, EI
Miranda.scheitlin@aecom.com
614-600-5804

A non-mandatory pre-bid meeting has been scheduled for May 12, 2020 @ 10:00 a.m. at the Richard A. Renneker Water Treatment Plant, 6193 Striker Road, Hamilton Township, Ohio. The County will review the project requirements with potential bidders, and receive questions. A visit the project site will be conducted after the meeting. Contact the Warren County Commissioners Office at (513) 695-1250 should you need assistance in accessing the bidding information on the County web site.

The project generally consists of the construction of a membrane softening addition to the existing Richard A. Renneker Water Treatment Plant to treat 13.7 MGD (expandable to 22.0 MGD) of groundwater. Improvements include a new nanofiltration softening building complete with NF softening equipment, pumps, process piping, valves, degasifiers, chemical feed systems, al all associated architectural, structural, HVAC, plumbing, electrical, instrumentation and controls work shown on the plans.

The Engineer's opinion of probable construction cost is $26,856,000.

The Board of Warren County Commissioners reserve the right to accept the lowest and best bid, to reject all bids, and to waive any irregularities in bids.

By order of the Board of County Commissioners, Warren County, Ohio.

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BOARD OF COUNTY COMMISSIONERS
WARREN COUNTY, OHIO

Resolution

Number 20-0545 *Adopted Date* April 14, 2020

ADVERTISE FOR BIDS FOR THE RICHARD A. RENNEKER WATER TREATMENT PLANT MEMBRANE SOFTENING UPGRADES PROJECT

BE IT RESOLVED, to advertise for bids for the Richard A. Renneker Water Treatment Plant Membrane Softening Upgrades Project for the Warren County Water and Sewer Department beginning April 27, 2020; and

BE IT FURTHER RESOLVED, to advertise said bid for one (1) week in a newspaper of general circulation two weeks prior to the bid opening date, and to advertise and make the bidding documents available on the County Internet Website, with bid opening to occur on May 28, 2020 @ 11:00 a.m.

Mr. Grossmann moved for adoption of the foregoing resolution, being seconded by Mrs. Jones. Upon call of the roll, the following vote resulted:

Mr. Young – yea
Mr. Grossmann – yea
Mrs. Jones – yea

Resolution adopted this 14th day of April 2020.

BOARD OF COUNTY COMMISSIONERS

Tina Osborne, Clerk

Cc: Water/Sewer (file)
OMB Bid file

SECTION 00 2113

INSTRUCTIONS TO BIDDERS

PART 1 GENERAL

1.1 GENERAL

A. Each Bidder shall include in the Bid a detailed account of its experience, skill, financial standing, and equipment available to perform the work. Each Bid must contain evidence of Bidder's qualification to do business in Ohio or covenant to obtain such qualification prior to award of the Contract.

B. The Owner may make investigations to determine the ability of the Bidder to perform the Work. When required, the Bidder shall present evidence of its experience in similar Work and that it has the necessary equipment and financial resources to provide materials and complete the Work in a satisfactory manner in the time specified.

C. No Bid will be accepted from, or Contract awarded to, any person, firm, or corporation in arrears or in default to the Owner upon any debt or Contract, or a defaulter as surety upon same, or has failed to perform faithfully any previous Contract with the Owner.

D. The Owner reserves the right to reject any Bidder who is in default on any debt or Contract or is a defaulter as surety upon same, or has failed to perform faithfully any previous Contract.

1.2 BIDDING DOCUMENTS

A. The Bidding Documents consist of all items listed in the Table of Contents. Requirements of any one item apply to the Work of all others. It is the responsibility of each Contractor and Subcontractor to review each Document in detail for Work of its trade and how the Work of other trades affects its Work.

B. Bidders shall use complete sets of Bidding Documents in preparing Bids. Neither the Owner nor the Engineer assumes responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

C. In making copies of the Bidding Documents available on the above terms, the Owner and the Engineer do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant permission for any other use of the Bidding Documents.

D. Specification Sections are edited from a master with fixed numbers. Therefore, Section numbers may not run sequentially. 33 0577 may be followed by 33 3000, etc. Pages of each Section are numbered consecutively, starting with Page 1. Each Section ends with the statement: “END OF SECTION _____". If any pages are missing from the issued Documents, contact the Engineer for replacement. Each Bidder is responsible for all Work shown or specified, whether or not pages are missing from an issued Document.

E. The organization of the Specifications into Divisions, Sections and Articles, and the arrangement of Drawings shall not control the Contractor in dividing the Work among

Subcontractors or in establishing the extent of Work to be performed by any trade. Each Section may be used as a unit of Work, or Sections may be combined as a unit of Work or subdivided into several units of Work.

F. The captions, headings or titles in this Project Manual are for convenience only and in no way define, limit or describe the scope or intent of any provisions, paragraphs, Divisions, or Sections of this Project Manual.

1.3 CONTRACT REQUIREMENTS

A. Type of Contract: Lump sum proposal.

B. Liquidated Damage: Refer to Division 01 Section "Supplementary Conditions".

C. Contract Completion: Refer to Section 00 5215, "Agreement between Owner and Contractor" for completion date requirements for substantial and final completion.

1.4 PREPARATION OF BIDS

A. General: The following items shall be used without variation by all Bidders and submitted with the Bid.
   1. Section 00 2113, "Instructions to Bidders". (for information only)
   2. Section 00 4113, "Bid Form".
   3. Section 00 4313, "Bid Security".
   4. Section 00 4325, "Substitution Request Form". (optional)
   5. Section 00 4333, "Proposed Products Form".
   6. Section 00 4336, "Proposed Subcontractor's Form".
   7. Section 00 4513, "Bidder's Qualifications".
   8. Section 00 4515, "Ohio EPA WSRLA Program Requirements"
      a. Contractor Equal Employment Opportunity (EEO) Certification
      b. Certification Regarding Debarment, Suspension, and Other Responsibility Matters.
      c. DBE Forms 6100-3 and 6100-4
      d. American Iron & Steel acknowledgement Form.
   9. Section 00 4519, "Non-Collusion Affidavit".
   10. Section 00 4529, "Personal Property Tax Disclosure Affidavit".
   11. Section 00 4539, "Finding's for Recovery Affidavit".
   12. Surety's Power of Attorney
   13. Certificate of Authorization to do business in Ohio (if applicable)

B. Fill in all blanks.

C. Bidders shall base their Bids on materials, equipment or processes specified.

D. Signatures
   1. Bids shall be signed with the name typed below the signature. If the Bidder is a corporation, Bid shall be signed with the legal name of the corporation, followed by the legal signature of an officer authorized to bind the corporation to a Contract. If other than a President or Vice President, a copy of authorization from the Board of Directors shall be attached. If the Bidder is a partnership, full names and addresses of each partner must be given and the Bid shall be signed by the number of partners required to bind the

partnership of the partners, using the term "Partner". If the Bidder is an individual, he shall use either the term "doing business as Builder" or "Sole Owner".

2. List the names and addresses of all parties financially interested in this Bid.

E. Bid Security

1. Each bidder shall submit with its bid a bid guaranty in the form of either a bond for the amount of 100 percent of the bid amount or a certified check, cashier's check, or letter of credit in the amount of 10 percent of the bid in accordance with Ohio Revised Code Section 153.54. The form of the bond shall be in accordance with the requirements of Ohio Revised Code Section 153.54.
2. The Bid security of Successful Bidder will be retained until such Bidder has executed the Agreement, furnished the required contract security and met the other conditions of the Notice of Award, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Agreement and furnish the required contract security within 10 days after receipt of the Notice of Award, Owner may annul the Notice of Award and the Bid security of that Bidder will be forfeited. The Bid security of other Bidders whom Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of the 7th day after the Effective Date of the Agreement or the 66th day after the Bid opening, whereupon Bid security furnished by such Bidders will be returned. Bid security with Bids which are not competitive will be returned within 14 days after the Bid Opening.
3. The Owner reserves the right to retain the Bid security of the three lowest Bidders until a responsible Bidder enters into Contract or until 90 days after Bid Opening Date, whichever is less.
4. If any Bidder refuses to enter into Contract, the Owner will retain its Bid Security as liquidated damages.

F. Questions and Answers: Should any Bidder find discrepancies, inconsistencies, ambiguities, errors, or obvious omissions in the Documents, or should it be in doubt as to meaning, Bidder shall notify Miranda Scheitlin at AECOM in writing by email (Miranda.scheitlin@aecom.com), who will send written instructions to all Bidders. Such notification must be received no later than 7 days before the bid date. The

1. Engineer will not be responsible for instructions not addressed in a formal addendum. Oral, written, electronic, or other interpretations or clarifications not issued in a formal addendum will be without legal effect.

G. A Pre-Bid Conference is scheduled for May 14, 2020 at 10 A.M. The meeting will be held at the Richard A. Renneker WTP (RARWTP), 6193 Striker Road, Maineville, Ohio. A tour of the visit of the project site will be conducted immediately after the meeting. It is highly recommended that all bidders attend this meeting.

H. Addendum

1. Bidders will be advised during the Bidding period by Addendum of additions or alterations to the Documents. Changes shall be included in the Work covered by the Bid and, in closing the Contract, will become a part thereof.
2. Bidders shall list on the Bid Form all addenda.

1.5 BIDDERS REPRESENTATION

A. Examination of Documents and Site

1. All Bidders shall visit the Site of the proposed Work during the Bidding period and shall inform themselves of all local conditions bearing on transportation, disposal, handling and storage of materials; other Work being performed; accessibility and general character of the Site; and extent of existing Work within or adjacent thereto.
2. The failure or omission of any Bidder to receive or examine any forms, instruments, or document, or to visit the Site and acquaint himself with conditions there existing shall in no way relieve any Bidder from any obligation with respect to its Bid.

B. Non-Collusion Affidavit: Complete in full the attached Non-Collusion Affidavit. Form shall be signed by the same person authorized to sign Bids.

C. Nondiscrimination In Employment
1. Contracts for Work under this proposal will obligate the Contractors and subcontractors not to discriminate in employment practices.
2. Bidders must, if requested, submit a compliance report concerning their employment practices and policies in order to maintain their eligibility to receive the award of the Contract.
3. Successful Bidders must be prepared to comply in all respects with the Contract Provisions regarding nondiscrimination.

D. License to do Business in Ohio: Corporations not chartered in Ohio shall include an affidavit executed by an officer of the corporation stating that the corporation has conformed with the provisions of the Revised Code of the State of Ohio and obtained a certificate authorizing it to do business in the State of Ohio. Certificates or copies of them shall be obtained from the office of the Secretary of State, Columbus, Ohio.

1.6 SUBMISSION OF BIDS

A. Submit Bids on or before the date stated in the Advertisement for Bids. No Bids will be considered after that time.

B. Submit the Bidding Package with forms completed and all necessary attachments in a sealed opaque envelope marked with:
1. Bidder's Name and Address
2. Signature of person signing the Bid
3. Project Name.

C. Deliver in person or send by mail, enclosed in a separate mailing envelope addressed to:

Warren County Board of Comissioners
406 Justice Drive
Lebanon, OH 45036

1. If mailed, enclose in a separate mailing envelope, mark "Bid Enclosed" on the face.

D. No oral or telegraphic Bids will be accepted.

E. Bids submitted early may be withdrawn by the Bidder by written request signed by the person signing the Bid. Such request must be received by the party receiving Bids prior to the Bid receipt deadline time.

F. If, within 48 hours after Bids are opened, any Bidder files a duly signed, written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a mistake in the preparation of its Bid, in accordance with the provisions of Section 9.31 of the Ohio Revised Code, that Bidder may withdraw its Bid and the Bid security will be returned. Thereafter, that Bidder will be disqualified from further bidding on the work to be provided under the Contract Documents.

G. After 48 hours, no Bid may be withdrawn for 90 days after scheduled closing time for receipt of Bids.

1.7 CONSIDERATION OF BIDS

A. Bid Opening: Properly identified Bids received on time will be publicly opened and read aloud.

B. Rejection of Bids
   1. The Owner reserves the right to reject any or all Bids, and shall have no liability whatsoever to any Bidder whose Bid is not accepted.
   2. Bid Packages containing irregularities, conditional or obscure language, or additions not requested by the Bidding Documents may be rejected.

C. Acceptance of Bids: Acceptance of a Bid will not constitute an Agreement between the Owner and Bidder, and will not be binding upon the Owner unless and until an Agreement covering all conditions and provisions of the Work has been reduced to writing and executed by both parties.

D. Bids to Remain Subject to Acceptance: All bids will remain subject to acceptance for ninety (90) days after the day of the Bid opening, but Owner may, at its sole discretion, release any Bid and return the Bid security prior to that date.

E. Low bidder will be determined by base bid, plus allowances, plus/minus any Owner selected alternates.

1.8 AWARD OF CONTRACT

A. Owner reserves the right to reject any or all Bids, including without limitation the rights to reject any or all nonconforming, nonresponsive, unbalanced or conditional Bids and to reject the Bid of any Bidder if Owner believes that it would not be in the best interest of the Project to make an award to that Bidder, whether because the Bid is not responsive or the Bidder is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criteria established by Owner. Owner also reserves the right to waive all informalities not involving price, time or changes in the Work and to negotiate contract terms with the Successful Bidder. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

B. In evaluating Bids, Owner will consider the qualifications of Bidders, whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data as may be requested in the Bid Form or prior to the Notice of Award.

C. Owner may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work to which the identity of Subcontractors, Suppliers, and other persons and organizations must be submitted as provided

in the Supplementary Conditions. Owner also may consider the operating costs, maintenance requirements, performance data and guarantees of major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

D. Owner may conduct such investigations as Owner deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.

1.9 SUBSTITUTE AND "OR-EQUAL" ITEMS

A. The Contract, if awarded, will be on the basis of materials and equipment described in the Drawings or specified in the Specifications without consideration of possible substitute or "or-equal" items. Whenever it is indicated in the Drawings or specified in the Specifications that a substitute or "or-equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered by Engineer until after the successful Contractor has been determined. The procedure for submission of any such application by Contractor and consideration by Engineer is set forth in the General Conditions, and as follows.

B. Substitution of Manufacturers
   1. Those articles, devices, materials, forms of construction fixtures, equipment, process or manufacturers named in the Specifications to denote the kind and quality required, whether or not the words "or equal" are used, shall be known as "standards".
   2. Where two or more "standards" are named together, the successful Bidder may furnish one of the "standards" named.
   3. Bidders desiring consideration for the use of material, equipment, etc. not named in the Specifications may submit the "Substitution Request Form" with the Proposal Form and listing for each change: (1) The "standard" specified, and the substitution, and (2) the deduct price associated with the proposed substitution. The price shall include all work associated with the proposed substitution, including but not limited to architectural, structural, electrical, engineering costs, and all related work.
   4. Substitutions will only be considered after the successful contractor has been determined. The successful contractor must submit complete specifications, samples, catalogs, data sheets, test results, and description of proposed substitutions within 3 days of notification to provide a sound basis for comparison with the specifications.
   5. The listing of substitutions at the time of bid is only required for those items listed on the Substitution Request Form. Substitutions for those items listed on the Substitution Request Form will only be considered if the proposed substitute is listed at the time of Bid. The offering and consideration of substitutions for other items may be made throughout the contract time.
   6. Any substitution which is accepted must be incorporated in the formal Contract by Change Order.

C. Substitution Request Form
   1. Bidders shall base their Bids on materials, equipment or processes described on the Drawings or specified in the Specifications without consideration of possible substitute or "or equal" items.

2. Bidders are invited to submit for consideration quotations for substitutes capable of performing the specified functions.
3. State on the Substitution Request Form submitted with the Bid the amount to be deducted from the amount of the Base Bid for each substitution of items listed.
4. When requested, submit complete specifications and descriptions of any items the successful bidder proposes to substitute, within 3 days of notification to do so.
5. Prior approval by Engineer is not required on items submitted on the Substitution Request Form.
6. Such substitutes will be accepted or rejected, and the Contract sum adjusted accordingly by Change Order.
7. After the Contract is awarded, no further substitutions will be permitted for the items listed, except as outlined on the Substitution Request Form.

D. Approval Process
1. The successful Contractor must submit complete specifications, samples, catalogs, data sheets, test results, and description of proposed substitutions to provide a sound basis for comparison with the specified items. Include a statement and explanatory Drawings showing all changes in related or adjacent Work. List every departure from the specified item.
2. The burden of proof is with the proposer of the substitution.
3. If, in the opinion of the Engineer, the item submitted does not meet with the intent of the design or is not equal to the item specified, it may disapprove it or, if it finds it in the interest of the Owner, it may approve such items submitted.
4. If the substitute is accepted, the Contractor shall pay all costs of extra labor and materials required by other Contractors and Subcontractors arising from the incorporation of substitutions into the Project, and provide additional Drawings as required by the Engineer. The substitution will be incorporated in the formal Contract by Change Order.

1.10 DECLARATION OF MANUFACTURER

A. The Drawings and Specifications have been designed around the manufacturer that is first listed in the Specifications for the item. This manufacturer shall be known as the Basis of Design.

B. Other acceptable manufacturers may be listed for each item. The Engineer has determined that similar equipment supplied by these additional manufacturers will be acceptable provided it will perform the necessary function, is of similar design, and meets the intent of the Contract Documents.

C. The bids submitted by the bidder must be based on one of the named manufacturers. Or equal, or other manufacturers must be included on the Substitution Request Form for consideration.

D. The bid forms contain a Proposed Products Form which must be completed for the items listed.

E. The bidder shall indicate, in the space provided, the manufacturer upon which it has based its bid, and the bidder agrees to supply equipment furnished by this manufacturer when performing the contract.

F. If the bidder fails to indicate which manufacturer it is basing its bid upon in the form, it is assumed, understood, and agreed that the bidder will furnish equipment supplied by the manufacturer listed as the "Basis of Design" for the particular equipment.

G. The declaration of manufacturers is only required for those items listed on the Proposed Products Form.

1.11 MINIMUM WAGE RATES

A. The minimum wage to be paid to all skilled labor, intermediate grade labor, and unskilled and common labor employed on this Project shall be in accordance with the Wage Determination ascertained and determined by the Ohio Bureau of Employment Services and subject to Federal Prevailing Wage Rates (Davis-Bacon Act).

B. The wage rates included herein are applicable as of the date of advertising for bids. However, Contractors must abide by the latest prevailing wage rate listing effective at the time of Bid opening and must update rates of wages paid to employees as changes in the wage rates occur. Contractors shall submit certified copies of payrolls to the Owner as required by law.

1.12 SMALL BUSINESSES IN RURAL AREAS

A. This procurement is subject to the EPA policy of encouraging the participation of small businesses in rural areas. It is EPA policy that recipients of EPA financial assistance awards utilize the services of small businesses in rural areas (SBRAs), to the maximum extent practicable. The objective is to assure that such small business entities are afforded the maximum practicable opportunity to participate as subcontractors, suppliers and otherwise in EPA-awarded financial assistance programs. This policy applies to all contracts and subcontracts for supplies, construction, and services under EPA grants or cooperative agreements. Small purchases are also subject to this policy.

1.13 POST-BID REQUIREMENTS

A. Contract Forms
   1. The following Contract Forms will be provided by the Engineer and shall be used without variation by the selected Bidder:
      a. Owner-Contractor Agreement
      b. Contract Bond (Performance and Payment Bonds)
         1) The Bidder shall deliver the required bonds to the Owner not later than 10 days following the date of receipt of the Notice of Award.
         2) If the Work is to be commenced prior thereto in response to a letter of intent, the Bidder shall, prior to commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished and delivered in accordance with this Subparagraph.
      c. MBE/WBE Form 5700-52A.
   2. Copies of each form will be furnished to the selected Bidder.

B. Submittals
   1. Comply with Division 01 Section “Submittal Procedures”.
   2. Submit the following items prior to Contract signing:
      a. Contract Bond (Performance and Payment Bonds)
   3. Lack of submission or an untimely submission shall be considered a Nonresponsive Bid and such Bid may be rejected.

PART 2 PRODUCT (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 2113

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SECTION 00 3132

GEOTECHNICAL DATA

PART 1 GENERAL

1.1 SOILS INFORMATION AND DISCLAIMER

A. The following subsurface investigation report was prepared by Terracon Consultants, Inc. for the Owner for use in design. Such reports and logs are not a part of the Contract Documents and are not to be relied upon as a complete representation of all possible soil conditions. The subsurface investigation reports and log are not approved by nor guaranteed in any manner by the Owner or Engineer. Use of the information is totally at the risk of the Contractor. Additional soils information, if needed by any Contractor, shall be obtained by the Contractor at no cost to the Owner.

PART 2 - PRODUCT (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 00 3132

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Geotechnical Engineering Report

RARWTP Membrane Softening Upgrades
Maineville, Warren County, Ohio
January 7, 2020
Terracon Project No. N1195378

Prepared for:
AECOM
Columbus, Ohio

Prepared by:
Terracon Consultants, Inc.
Cincinnati, Ohio

Preliminary Report issued on May 24th, 2019
Revised on January 7, 2020

AECOM
277 W. Nationwide Blvd.
Columbus, Ohio 43215

Attn: Mr. Matthew S. Noelker, PE
P: (614) 549-0933
E: matthew.noelker@aecom.com

Re: Geotechnical Engineering Report
RARWTP Membrane Softening Upgrades
6391 Striker Road
Maineville, Warren County, Ohio
Terracon Project No. N1195378

Dear Mr. Noelker:

We have revised our preliminary geotechnical report for the proposed expansion of the Renneker Water Treatment Plant (RARWTP) dated May 24, 2019. Our supplemental services were performed in general accordance with Terracon Proposal No. PN1195380 dated October 31, 2019 and authorized on November 6, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

STATE OF OHIO
CRAIG M. DAVIS
E-65462
REGISTERED PROFESSIONAL ENGINEER
1/7/20

Anurupa S. Kumar, EIT
Staff Geotechnical Engineer

Craig M. Davis, PE, CPESC
Geotechnical Department Manager

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report

RARWTP Membrane Softening Upgrades

6391 Striker Road

Maineville, Warren County, Ohio

Terracon Project No. N1195378

Preliminary Report issued on May 24, 2019

Revised on January 7, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Renneker Water Treatment Plant (RARWTP) improvement project located at 6391 Striker Road in Maineville, Warren County, Ohio. The purpose of these services is to provide geotechnical engineering recommendations relative to:

- subsurface soil and rock conditions
- site preparation and earthwork
- floor slab design and construction
- general pavement subgrade design parameters
- short-term groundwater conditions
- foundation design and construction
- seismic site classification per IBC

The geotechnical engineering Scope of Services for this improvement included the advancement of six test borings (2R to 7R) to depths ranging from approximately 27 to 33.8 feet below existing site grades within the proposed development area. In addition, one boring (1R) was drilled to a depth of approximately 31.5 feet below existing site grades at the proposed cascade aerator location.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on select soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly-available geologic and topographic maps.

Item	Description
Parcel Information	■ The project is located at 6391 Striker Road in Maineville, Warren County, Ohio. ■ Latitude: 39°20'46.66"N, Longitude: 84°14'28.86"W (approximate) ■ See **Site Location**
Existing Conditions	■ Existing WTP buildings and infrastructure associated with the existing high service pump station, UV disinfection systems, filters and detention tanks to the east of proposed expansion area. Based on review of historical aerial imagery, it appears that former buildings and associated pavements had been demolished sometime between 2006 and 2009. It is our understanding that the former building foundations were not completely and were partially demolished (up to 3-feet below existing site grades) and then abandoned in-place. ■ Little Miami River (into which cascade aerator is planned to discharge) with wooded area to the east.
Existing Topography (from Grading Plan provided)	■ Grades at the proposed WTP expansion area vary from an elevation of about 760 feet to 764 feet, mean sea level. ■ Grades at the cascade aerator location vary from an elevation of about 601 feet to 604 feet, mean sea level.
Site Geology	Based on NCRS soil map, surficial soils at the site are mapped as the Clermont and Cincinnati silt loam soils. Based on publicly-available bedrock geology maps, the overburden soils on site are underlain by the Ordovician age bedrock belonging to the Grant Lake and Fairview Formations" which consist of interbedded shale and limestone.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated and our understanding of the project conditions is as follows:

Item	Description
Information Provided	■ All preliminary information for this project was provided via correspondence with Infrastructure & Development Engineering (IDE), Arcadis US, Inc. and AECOM, the provided scope document, and aerial maps/site plans. ■ Soil Boring Locations for RARWTP Membrane Softening Upgrades and Cascade Aerator prepared by AECOM (dated February 28, 2019). ■ RARWTP Membrane Softening Upgraded Drawing Set (Architectural, Civil and Structural) last plotted on October 25, 2019.

Item	Description
Project Description	■ It is planned to expand the existing treatment plant with a single-story NF membrane softening building (approximately 99' long x 88' wide) with a basement level, a tank (28' long x 54' long) and a chemical feed building and a generator pad (12' long x 50' long). ■ A concentrate disposal line will be installed connecting the NF membrane building to an outfall that will discharge into the Little Miami River with a cascade aerator at the headwall. Terracon already completed the test borings within the NF building footprint in April 2019. Please refer to Preliminary Geotechnical Engineering Report for RARWTP Membrane Softening Upgrades Report prepared by Terracon on May 24th, 2019.
Proposed Structure	Pre-engineered metal building with masonry walls.
Finished Floor Elevation (FFE)	■ Upper basement level FFE, to be supported on mat foundation: 759.67 feet, MSL ■ Lower basement level FFE, to be supported on mat foundation: 746.5 feet, MSL ■ Upper floor FFE at southwest corner of the building to be supported on conventional spread footings: 761 feet, MSL ■ Cascade aerator FFE, to be supported on conventional spread footings: 598 feet, MSL
Maximum Loads (From email conversation and drawings provided by Arcadis)	It is anticipated that the maximum building loads will be: ■ Columns: 50 to 250 kips ■ Walls: 2.5 to 5.5 kips per linear foot (klf) ■ Contact pressure for upper basement level mat foundation: 3,000 psf ■ Contact pressure for lower basement level mat foundation: 4,000 psf ■ Slabs: 100 to 300 pounds per square foot (psf) ■ Generator pad: 250 pounds per square foot (psf) Maximum loads for the cascade aerator were not provided to Terracon. Below grade portions of the NF Building will not incorporate a base drainage system. According to Aracadis, the buoyant forces will be balanced by the weight of the structures.
Grading/Slopes (Sheets C-12 and C-13)	Up to 8 feet of fill and minimal (less than 2-feet) cut will be required to achieve final site grades. Deeper cuts (about 6.5 to 16.5 feet) will be required within the proposed detention basin, NF building and tank areas.
Pavements	Asphalt pavement sections to match existing features.
Estimated Start of Construction	2020

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	FILL	lean clay or sand, with gravel
2	LEAN CLAY	trace gravel and sand, reddish-brown/brown trace gray, soft to very stiff
3	LEAN CLAY (Brown glacial till)	with cobbles, some gravel and sand, light brown, hard
4	LEAN CLAY (Gray glacial till)	with cobbles, some gravel, sand and silt, gray, hard
5	SAND	trace gravel, fine to coarse grained, light brown, very loose to dense
6	INTERBEDDED SHALE AND LIMESTONE	Shale: brownish-gray to gray, extremely weak to weak, moderately weathered to unweathered Limestone: light gray, medium strong to strong, unweathered

Glacial till is a dense conglomerate of silt, clay, sand and gravel that has been mixed, deposited and consolidated by the actions of glacial ice movement. It is commonly encountered with cobble-size fragments and meltwater channel deposits of silt and sand. These channels occasionally transmit groundwater. Glacial till is typically over-consolidated due to its depositional method and was identified in two (2) distinct zones in the test borings. The uppermost zone of glacial till is brown in color and is typically visually classified as hard in consistency. The deeper glacial till is gray in color and also visually classified as hard.

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**. However, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Perched groundwater is often

encountered at the fill/natural soil interfaces, within existing fill, within granular zones or seams amongst the glacial tills, at the overburden soil/bedrock interface or within seams, bedding planes or fractures within the bedrock. As a result, perched water could be encountered during construction. Some of the test borings for this study revealed the presence of interbedded sand layers and groundwater was observed in some of these layers. The presence of groundwater and quantity/rate of seepage within excavations in these layers will depend on several factors, including their hydraulic connectivity and regional hydrogeology. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The test borings within the proposed WWTP development area (2R through 7R) encountered primarily cohesive soils. Cohesive and granular fill was encountered in Borings 4R, 5R and 6R (located within the footprint of former structures/building at the project site) up to depths ranging from about 4 to 12 feet. The overburden soils are underlain by bedrock at depths ranging from about 12 to 23 feet below existing site grades. Bedrock was not encountered at Boring 4R within the explored depth of approximately 31.5 feet.

Test Boring 1R at the proposed cascade aerator location encountered about 7.5 feet of cohesive soils underlain by silty sands/sand to the boring termination depth of approximately 31.5 feet. Bedrock was not encountered at Boring 1R within the explored depths.

In general, the upper 5 to 10 feet of the soil profile has a low stiffness/density. Since the NF Building will bear at multiple levels, both in and below this stratum of low stiffness, differential settlement may be a concern.

The near surface, soft to stiff cohesive soils and silty sands could become unstable with typical earthwork and construction traffic, especially after precipitation events. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

Support of floor slabs and pavements on or above existing fill materials is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report. To take advantage of the cost benefit of not removing the entire amount of undocumented fill, the owner must be willing to accept the risk associated with building over the undocumented fills

following the recommended reworking of the material and extending foundations to bear in competent native soils.

The **Pavements** section addresses recommended pavement subgrade design parameters. The **Floor Slabs** section addresses slab-on-grade support of the building. The **Shallow Foundations** section addresses support of the building bearing on native at-least stiff clay, at-least medium dense sand or new engineered fill.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Based on review of RARWTP Membrane Softening Upgrades Drawings (Sheet C-07), abandoned foundations for the former reaction tanks, filter beds, chemical building and pressure feed building are located within the proposed NF building footprint, about 3 feet below existing site grades. All existing/abandoned foundations elements or concrete pads remaining on-site should be completely excavated and removed. All existing underground utilities within the proposed building footprint should be removed or relocated at least 10-feet beyond of the perimeter of the proposed building. Any utilities to be abandoned should be removed or grouted full in-place to prevent future collapse, which could result in subsidence of overlying elements. Excavations created during these activities should be backfilled with structural fill, placed and compacted in accordance with the recommendations provided in this report, or with low-strength mortar otherwise known as flowable fill. If lean concrete is used as backfill, the contractor should refer to the Mechanical-Electrical-Plumbing (MEP) plan and foundation details for the new building to confirm that the concrete backfill material will not conflict with any new installations, floor slabs and utilities associated with the proposed building. Stripped gravel base material can be stockpiled for re-use. Unsuitable materials should be hauled off-site.

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas. The stripped topsoil is not suitable for reuse as engineered fill and should be stockpiled for use in future landscape areas. All vegetation and any otherwise unsuitable material should also be removed from the construction areas prior to site grading. Because of the medium stiff consistency of the near surface soils, additional stripping/undercutting should be anticipated due to rutting of the

subgrade. Medium stiff natural cohesive soils were encountered immediately beneath the topsoil from depths ranging from about 1.5 to 7.5 feet below existing grades. The actual depth of soft soils will depend on the weather conditions prior to construction.

After stripping and grubbing, the subgrade should be proofrolled with a minimum 20-ton vehicle such as a fully-loaded tandem-axle dump truck. The proofrolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be undercut and replaced or modified by chemical stabilization. Based on laboratory testing, natural moisture contents of the near surface soils were generally in the twenties to thirties (percent). These upper soils are not expected to pass the recommended proof-rolling tests in that condition and will likely require modification prior to placement of engineered fill or foundation, floor slab, or pavement construction.

Existing Fill

Existing fill was identified at test borings 5R and 6R (within proposed NF building footprint) at depths varying from about 4 to 12 feet. Based on the presence of organic, low-density and variable thickness of the fill material encountered, it is anticipated that the existing fill was placed with limited compactive effort and is not suitable for direct structural support. Based on the grading plan provided, it is our understanding that the FFE of basement level will be at El. 746.5 feet, which is about 16 to 18 feet below existing site grades. It is anticipated that existing fill within the NF building footprint will primarily be undercut during excavation to achieve design basement level, with an exception of the west side of the building footprint where shallower footings at El. 758.6 feet (about 4 feet below existing site grades) are planned.

Support of pavements and floor slabs on or above existing fill soils, is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report.

If the owner elects to construct floor slabs on the existing fill, the following protocol should be followed. Once the planned grading has been completed, the areas of existing fill should be undercut 2-feet within the building areas. Once materials have been removed, the entire area should be proofrolled with heavy, rubber tire construction equipment, to aid in delineating areas of soft or otherwise unsuitable soil. Once unsuitable materials have been remediated, and the subgrade has passed the proofroll test, the existing and undocumented fill that was removed can be evaluated for reuse as structural fill.

If the owner elects to construct pavements on the existing fill, the following protocol should be followed. Once the planned subgrade elevation has been reached the entire pavement area

should be proofrolled. Areas of soft or otherwise unsuitable material should be undercut and replaced with either imported granular fill or suitable, existing on site materials.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas. Earthen materials used for structural fill should meet the following material property requirements:

Soil Type [1]	USCS Classification	Acceptable Location for Placement
Low Plasticity Cohesive	CL (LL<40 & PI>15)	All locations and elevations
Moderately Plasticity Cohesive	CL (40<LL<50)	>3 feet below slab-on-grade or pavement
Granular	GW[2]	All locations and elevations where adequate drainage is provided.
On-site soils	Varies	The on-site soils can be reused as fill; provided they meet the aforementioned criteria. Significant moisture conditioning may be needed.

1. Structural fill should consist of approved materials free of organic matter and debris. Rock fragments should be limited to maximum 6-inch dimensions. Frozen material should not be used. Fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site. The suitability of excavated on-site soils should be evaluated in the field during construction.
2. Like ODOT No. 304 stone or crushed limestone aggregate or granular material such as sand, gravel or crushed stone containing no more than 18% low plasticity fines.

The over-excavation for the lower level basement at FFE 746.5 feet may be achieved using an open excavation with steepened side-slopes. If this is the case, this will result in an approximately 15-feet wide and approximately 14-feet deep wedge (below the portion of the NF building supported on the higher mat foundation at FFE of 759.67 feet) which will have to be backfilled to achieve design subgrade elevation. It is our recommendation that this wedge be backfilled with granular material meeting the criteria listed in the table above.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill
Maximum Lift Thickness	■ 8-inches or less in loose thickness when heavy, self-propelled compaction equipment is used ■ 4 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1, 2, 3]	98% of the material's Standard Proctor maximum dry density (ASTM D 698) [1]
Water Content Range [1]	■ Low Plasticity Cohesive Soil (LPS): Within ±3% of optimum moisture content (OMC) as determined by the Standard Proctor test at the time of placement and compaction ■ Granular Material: Within ±2% of OMC/within workable moisture levels [2]

1. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirement are achieved.
2. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proofrolled.

Utility Trench Backfill

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

The subsurface profile at the site includes interbedded sand layers that could be water bearing. The magnitude and rate of seepage within excavations in these layers will depend on rainfall,

hydrogeology and hydraulic connectivity of these layers. Temporary excavation support may be necessary to stabilize excavation side walls and dewatering may be necessary to control seepage. The contractor is responsible for groundwater control during construction. The groundwater seepage could affect over-excavation efforts, especially for replacement of lower strength soils and basement excavation. A temporary dewatering system consisting of sumps with pumps could be necessary to achieve the recommended depth of over-excavation.

It is our understanding that the design groundwater level is being considered at El. 754 feet, which is about 7.5 feet above the lower basement level FFE. Arcadis will establish the level as the cut-off for buoyant forces to apply. Based on information provided by Arcadis, a perimeter foundation drain will be installed at an elevation of about 751.5 feet, creating a potential for up to 5-feet of hydrostatic pressure above the lower level basement floor. The backfill material surrounding the perimeter drains should consist of free-draining granular material (wrapped in geofilter material), with a minimum 2-feet thick clay cap just below existing site grades to reduce the infiltration of surface water into the backfill zone. Considerations must be given to providing cleanouts for the maintenance of the perimeter drain. With the provision of the perimeter drain, buoyancy/floatation of the basement is not considered to be a concern.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Grading and Drainage

All grades must provide effective drainage away from the proposed structures during and after construction and should be maintained throughout the life of the structure. Water retained next to the structures can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure’s maintenance program. Where paving or flatwork abuts the

structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the structural areas and 5,000 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

FOUNDATIONS

Mat Foundations

Based on information provided by AECOM, the basement level of the NF building is to be supported on a mat foundation with design bottom-of-foundation elevation at 744.5 feet. Majority of the western portion of the NF building will be supported on a shallower mat foundation with a design bottom-of-foundation elevation at 758.67 feet. The upper mat will be partially supported on the backfill of the lower level. The table below summarizes the estimated settlement and recommended design modulus of subgrade reaction for the mat foundations.

Item	Shallower Mat Foundation (FFE: 759.67 feet)	Deeper Mat Foundation (FFE: 745.5 feet)
Contact Pressure provided by Arcadis (psf)	3,000	4,000
Estimated Total Settlement (in)	1.5	1.0
Estimated Differential Settlement (in)	0.75	0.5
Modulus of Subgrade Reaction (psi/in)	13	28

These empirical estimates of settlement indicate a potential differential settlement of 0.5 inches. In order to mitigate this potential, the low-density soil zone can be entirely, or partially undercut and replaced with structural fill. This process may be simplified since the majority of the mat will be supported on the lower-level backfill. It is therefore critical that the backfill be properly placed as described herein and to the degree for structural support.

The generator pad to be located to the east of the NF building will be supported on a mat foundation (approximately 20' long x 50' long). Estimated total settlement of structure is anticipated to be less than 0.25-inches.

Spread Footings

For isolated column and wall footings of the chemical feed building and other ancillary structures, the table below summarizes the design parameters.

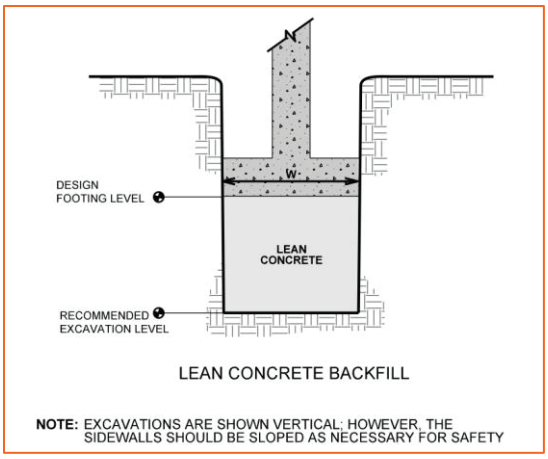
Item	Description
Allowable Bearing Pressure	■ At-least stiff native lean clay (Geomodel Layer No. 2): 3,000 psf ■ At-least stiff brown/gray glacial till (Geomodel Layer No.3 and Geomodel Layer No.4): 5,000 psf
Minimum Footing Dimensions for Spread Footings	■ Columns: 30 inches ■ Continuous: 18 inches
Ultimate Passive Resistance [2] **(equivalent fluid pressures)**	250 pcf
Ultimate Coefficient of Sliding Friction [3]	■ 0.35 (cohesive) ■ 0.45 (granular)
Minimum Embedment below Finished Grade [4]	■ Exterior footings: 30 inches (for frost protection) ■ Interior footings in heated areas: 12 inches
Estimated Total Settlement [1, 5]	Less than 1-inch
Estimated Differential Settlement [1, 5]	About 2/3 of total settlement

1. Values provided are for maximum loads noted in **Project Description**.
2. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
3. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
4. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
5. Differential settlements are as measured over a span of 50 feet for wall footings.

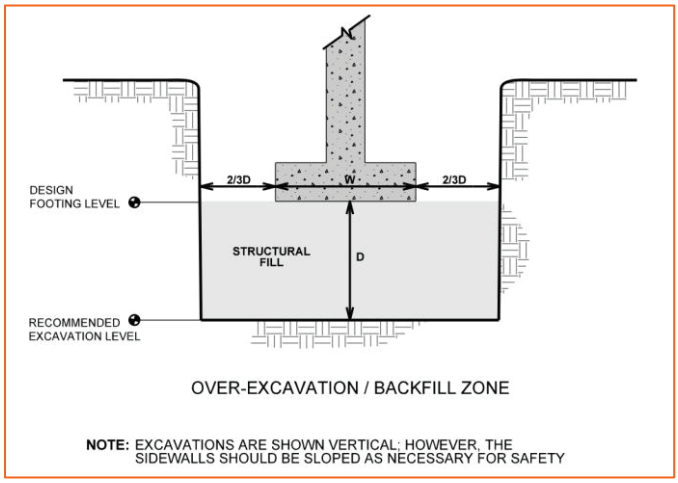
Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils (existing fill, soft to medium stiff clay or very loose to loose silty sand/sands) are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill (f'c min = 1,000 psi) placed in the excavations. This is illustrated on the sketch below.



If unsuitable existing soil are encountered up to depths greater than 1.5 times the footing width, consideration should be given to using compacted crushed stone backfill, up to the footing bearing elevation in leiu of using lean concrete. Over-excavation for compacted (as recommended in the **Earthwork** section) crushed stone fill placement below footings should be conducted as shown below. Consideration could also be given to using triaxial geogrid in the granular fill to improve compaction and performance of the granular fill. The lateral extension would allow for stresses distributed from the footings to dissipate laterally and with depth throughout the new structural backfill. This is illustrated on the sketch below.



SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil/bedrock properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is C** at the proposed membrane softening building site and **Seismic Site Classification is D** at the proposed cascade aerator location. Subsurface explorations at this site were extended to a maximum depth of 33.8 feet. Most borings were terminated in bedrock with an exception of 1R and 4R. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth or to investigate the use of an improved site classification.

FLOOR SLABS

Depending upon the finished floor elevation, unsuitable, weak, soft to medium stiff soils or existing fill may be encountered at the floor slab subgrade level. These soils should be replaced with structural fill so the floor slab is supported on at least 2-feet of compacted suitable natural soils or structural fill. Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	Minimum 6 inches of free-draining (less than 6% passing the U.S. No. 200 sieve) crushed aggregate compacted to at least 98% of ASTM D 698 [2, 3]
Estimated Modulus of Subgrade Reaction [2]	100 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.
3. Free-draining granular material should have less than 5% fines (material passing the No. 200 sieve). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.
Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in **Existing Fill** within **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor

slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

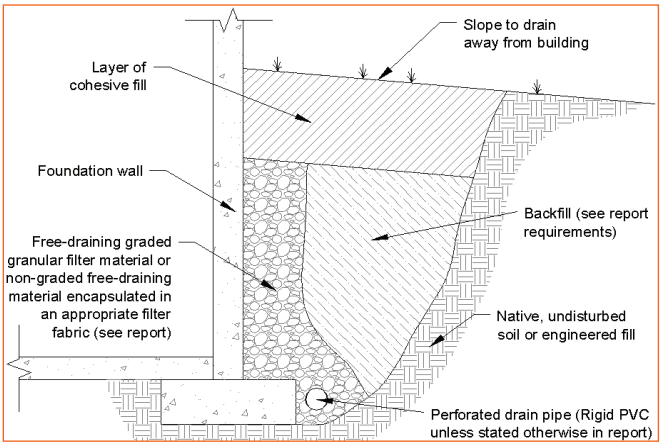
Structures with unbalanced backfill levels should be designed for earth pressures at least equal to the parameters indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. We recommend that the "at-rest" lateral earth pressure model be considered at the NF building with partially submerged conditions (up to the perimeter drain level), a multi-soil retained profile and surcharge pressures from the upper mat. The values in the table below do not include a safety factor and represent the average expected conditions surrounding the structures. If a more refined model of lateral earth pressures at specific location(s) is required to achieve a viable structural design, please contact us.

Soil Material	Soil Properties	At-Rest (K_o) Earth Pressure Coefficient	Surcharge Pressure (psf) [3]	Unsaturated Effective Fluid Pressures (psf)	Submerged Effective Fluid Pressures (psf) [4]
Geomodel Layer 1, 2	Y_m = 120 pcf Φ = 28° [1]	0.5	(0.50)S	(60)H	(91)H
Geomodel Layer 3,4	Y_m = 130 pcf Φ = 32°	0.47	(0.47)S	(61)H	(94)H
Granular Import [2]	Y_m = 120 pcf Φ = 32°	0.47	(0.47)S	(56)H	(89)H

1. Fill (Geomodel Layer 1) is presumed to be primarily cohesive. Granular fill is considered to be spatially limited and will not affect the lateral earth pressure model.
2. Uniform, horizontal backfill, compacted to at least 98% of the ASTM D 698 maximum dry density, rendering maximum moist and saturated unit weight of 120 pcf and 125 pcf, respectively.
3. Uniform surcharge, where S is surcharge pressure. Loading from heavy compaction equipment is not included.
4. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

PAVEMENTS

Support characteristics of subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as soils encountered on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

Pavement Design Parameters

A subgrade CBR of 3 can be used for the asphalt pavement designs, and a modulus of subgrade reaction of 100 pci can be used for the concrete pavement designs, following extensive undercutting, drying and/or chemical modification of upper soils, as required. The values were empirically derived based upon our experience with the encountered subgrade soils and our

understanding of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Based on the possibility perched groundwater, we recommend that drainage be carried out by sloping the terrain or by installing a pavement subdrain system to control groundwater, improve stability, and improve long-term pavement performance.

We recommend pavement subgrades be crowned at least 2% to promote the flow of water towards the subdrains, and to reduce the potential for ponding of water on the subgrade.

The subdrains should be hydraulically connected to the free-draining granular base layer. Subdrains should be sloped to provide positive gravity drainage to reliable discharge points such as the storm water detention basin. Periodic maintenance of subdrains is required for long-term proper performance.

Pavement Maintenance

Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install below pavement drainage systems surrounding areas anticipated for frequent wetting.

- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.

Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental, ecological or biological assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location

of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

Contents:

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Boring Location
6	27 to 33.8	Proposed WWTP development area
1	31.5	Proposed cascade aerator

Boring Layout and Elevations: The boring layout was provided by AECOM. The coordinates and elevation at the test boring locations were provided to Terracon by IDE.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous-flight hollow-stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling was performed using split-barrel sampling procedures. In the split-barrel sampling procedure, a standard 2-inch outer-diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded short-term groundwater levels during drilling and sampling. No long-term groundwater observations were planned. The borings were backfilled with auger cuttings upon completion.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

The laboratory testing program included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location
Exploration Plans A and B

Note: All attachments are one page unless noted above.

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or [$Cc<1$ or $Cc>3.0$] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or [$Cc<1$ or $Cc>3.0$] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"		CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K, L, M]
			PI plots below "A" line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

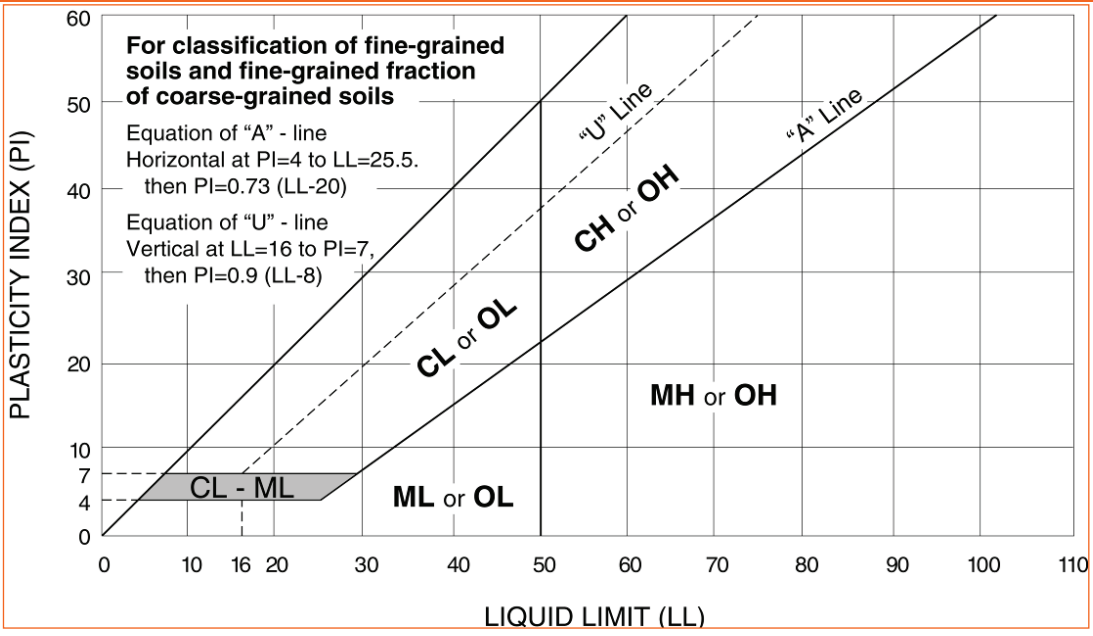
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft. (50 – 300 mm)
Moderate	8 in – 2 ft. (200 – 600 mm)	**Medium**	1 ft. – 3 ft. (300 – 900 mm)
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	**Thick**	3 ft. – 10 ft. (900 mm – 3 m)
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	**Massive**	> 10 ft. (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009
Technical Manual for Design and Construction of Road Tunnels – Civil Elements

DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)	
Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [1]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

1. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) [1]

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

1. RQD (given as a percentage) = length of core in pieces 4 inches and longer / length of run

Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

SECTION 00 4113

BID FORM

TABLE OF CONTENTS

ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted via hand delivery, USPS, UPS or FedEx to:

Warren County Administration Building
406 Justice Drive
Lebanon, OH 45036

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – BIDDER'S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 90 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 – BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, other related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date

B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Bidder has carefully studied all: drawings and applicable reports of physical conditions relating to existing surface or subsurface conditions at the Site.

E. Bidder has considered the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures

of construction expressly required by the Bidding Documents; and (3) Bidder's safety precautions and programs.

F. Based on the information and observations referred to in Paragraph 3.01.E above, Bidder does not consider that further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.

ARTICLE 4 – BIDDER'S CERTIFICATION

4.01 Bidder certifies that:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 5 – BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

A. General Trades

_____	Dollars	$ _____
(Words)		(Figures)

5.02 Allowances:

A. Tools and Maintenance Equipment

Fifteen thousand	Dollars	$ 15,000.00
(Words)		(Figures)

B. Office Furniture

Ten thousand	Dollars	$ 10,000.00
(Words)		(Figures)

C. Materials Testing

Forty thousand	Dollars	$ 40,000.00
(Words)		(Figures)

D. Local Utility Company

Forty thousand	Dollars	$ 40,000.00
(Words)		(Figures)

E. Trailer Mounted Valve Operator

Fifteen thousand	Dollars	$ 15,000.00

F. Security System

Seventy thousand	Dollars	$ 70,000.00
(Words)		(Figures)

G. NFC Cleanouts and CCTV

Forty-five thousand	Dollars	$ 45,000.00
(Words)		(Figures)

H. Lab Equipment

Five thousand	Dollars	$ 5,000.00
(Words)		(Figures)

I. SCADA

Twenty thousand	Dollars	$ 20,000.00
(Words)		(Figures)

5.03 Base Bid Plus Allowances:

_____ Dollars _____
(Words) (Figures)

5.04 Alternates

A. No Alternates.

ARTICLE 6 – TIME OF COMPLETION

6.01 Bidder agrees that the Work will be substantially complete within the number of calendar days specified in Section 00 5215 "Agreement between Owner and Contractor" after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and will be completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within the number of calendar days specified in 00 5215 after the date when the Contract Times commence to run.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 – ATTACHMENTS TO THIS BID

7.01 The following documents are submitted with and made a condition of this Bid:

A. See Section 00 4393.

ARTICLE 8 – DEFINED TERMS

8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

BID SUBMITTAL

8.02 This Bid is submitted by:

If Bidder is:

An Individual

Name (typed or printed): _____

By: _____
(Individual's signature)

Doing business as: _____

A Partnership

Partnership Name: _____

By: _____
(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed): _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____
Type (General Business, Professional, Service, Limited Liability):_____

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____
(CORPORATE SEAL)

Attest _____

Date of Qualification to do business in Ohio is ____/____/____.

A Joint Venture

Name of Joint Venture: _____

First Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of first joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Second Joint Venturer Name: _____(SEAL)

By: _____
(Signature of second joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

Bidder's Business Address _____

_____

Phone No. _____ Fax No. _____

E-mail _____ _____

SUBMITTED on _____, 20____.

END OF SECTION 00 4113

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DOCUMENT 00 4313

BID SECURITY

FORM OF BID GUARANTY AND CONTRACT BOND
(As prescribed by Ohio Revised Code Section 153.571)

KNOW ALL PERSONS BY THESE PRESENTS, that we, the undersigned,

_____, as Principal, at

_____ (Address)

and _____ as Surety, are hereby held and firmly bound unto the Warren County Board of Comissioners as Oblige, in the penal sum of the dollar amount of the Bid submitted by the Principal to the Obligee on (date) _____ to undertake the Project known as:

Project Name: Richard A. Renneker Water Treatment Plant (RARWTP) Membrane Softening Upgrades

The penal sum, referred to herein, shall be the dollar amount of the Principal's Bid to the Obligee, incorporating any additive alternate Bids made by the Principal on the date referred to above to the Obligee, which are accepted by the Obligee. In no case shall the penal sum exceed the amount of dollars ($_____). (If the preceding line is left blank, the penal sum will be the full amount of the Principal's Bid, including add alternates. Alternatively, if completed, the amount stated shall not be less than the full amount of the Bid, including Alternates, in dollars and cents. A percentage is not acceptable.) For the payment of the penal sum well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, that whereas the above-named Principal has submitted a Bid for the above referenced Project;

NOW, THEREFORE, if the Obligee accepts the Bid of the Principal, and the Principal fails to enter into a proper contract in accordance with the Contract bid, Plans, Specifications, details and bills of material; and in the event the Principal pays to the Obligee the difference, not to exceed ten percent of the penal sum hereof between the amount specified in the Bid and such larger amount for which the Obligee may in

good faith contract with the Bidder determined by the Obligee to be the next lowest responsive and responsible to perform the Work covered by the Bid; or in the event the Obligee does not award the Contract to such next lowest responsive and responsible Bidder and resubmits the Project for bidding, the Principal pays to the Obligee the difference not to exceed ten percent of the penal sum hereof between the amount specified in the Bid, or the costs, in connection with the resubmission, of printing new Contract Documents, required advertising and printing and mailing notices to prospective Bidders, whichever is less, then this obligation shall be null and void, otherwise to remain in full force and effect. If the Obligee accepts the Bid of the Principal, and the Principal, within 10 days after the awarding of the Contract, enters into a proper Contract and executes the Contract Form in accordance with the Contract Documents, including without limitation the Bid, Plans, Specifications, details, and bills of material, which said Contract is made a part of this Bond the same as though set forth herein; and

NOW ALSO, IF THE SAID Principal shall well and faithfully perform each and every condition of such Contract; and indemnify the Obligee against all damage suffered by failure to perform such Contract according to the provisions thereof and in accordance with the Contract Documents, including without limitation Plans, Specifications, details, and bills of material therefore; and shall pay all lawful claims of Subcontractors, Material Suppliers and laborers for labor performed and materials furnished in the carrying forward, performing or completing of said Contract; we, agreeing and assenting that this undertaking shall be for the benefit of any Subcontractor, Material Suppliers or laborer having a just claim, as well as for the Obligee herein; then this obligation shall be void; otherwise the same shall remain in full force and effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall in no event exceed the penal amount of this obligation as herein stated.

THE SAID Surety hereby stipulates and agrees that no modifications, omissions or additions, in or to the terms of said Contract, the Work thereunder or the Contract Documents, including without limitation the Plans and Specifications, therefore, shall in any way affect the obligations of said Surety on its bond, and it does hereby waive notice of any such modifications, omissions or additions in or to the terms of the Contract, the Work, or the Contract Documents, including without limitation the Plans and Specifications.

SIGNED AND SEALED this _____ day of _____ , _____
day month year

PRINCIPAL:

_____

By: _____

Title: _____

SURETY: _____

By: _____
Attorney-in-Fact

SURETY INFORMATION:

_____
Street

_____
City State Zip

_____
Telephone Number

SURETY AGENT'S INFORMATION:

_____
Agency Name

_____
Street

_____
City State Zip

_____
Telephone Number

END OF SECTION 00 4313

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SECTION 00 4325

SUBSTITUTION REQUEST FORM

PART 1 GENERAL

1.1 CONDITIONS OF SUBSTITUTION

A. Submit Bids based upon the materials and equipment specified.

B. List proposed substitutions below, together with the sum to be added to or deducted from the amount of the Base Bid. The amount to be added or deducted shall include all related required changes resulting from the substitution such as all required time and fees for the Engineer. Substitutions will only be permitted if selected by the Engineer.

C. After the Contract is awarded, no further substitutions will be permitted for the items listed.

LIST OF PROPOSED SUBSTITUTIONS

Item		Substitution Manufacturer
Motor Control Centers (Section 26 2419)		
Variable Frequency Drives (Section 26 2923)		
Vertical Turbine Pumps and Appurtenances (Section 43 2100.02)		
Horizontal End Suction Pumps (Section 43 2100.23)		
Forced Draft Degasifier Towers (Section 43 3225)		
Chemical Peristaltic Metering Pumps and Appurtenances (Section 46 3344)		
Polyethylene Chemical Storage Tanks and Appurtenances (Section 46 3393.01)		
Cartridge Filters (Section 46 6320)		

END OF SECTION 00 4325

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SECTION 00 4333

PROPOSED PRODUCTS FORM

PART 1 GENERAL

A. Bidder must complete this sheet for the listed items.

B. Circle the Manufacturer that bidder is proposing.

C. If the manufacturer for an item is not circled; or if more than one manufacturer is circled; the first manufacturer listed (from left to right) will be the declared manufacturer.

D. See the Instructions to Bidders for additional information.

LIST OF PROPOSED MANUFACTURERS

Item		Declared Manufacturer
Motor Control Centers (Section 26 2419)		Allen-Bradley; Cutler-Hammer; Square D
Variable Frequency Drives (Section 26 2923)		Allen-Bradley; Eaton
Vertical Turbine Pumps and Appurtenances (Section 43 2100.02)		Floway; Flowserve; Peerless
Horizontal End Suction Pumps (Section 43 2100.23)		Flowserve; Sulzer
Forced Draft Degasifier Towers (Section 43 3225)		DeLoach Indistries, Inc.; Tonka Equipment Co.
Chemical Peristaltic Metering Pumps and Appurtenances (Section 46 3344)		Watson Marlow Qdos
Polyethylene Chemical Storage Tanks and Appurtenances (Section 46 3393.01)		Flat Bottom: Poly Processing Conical Bottom: Snyder Industries
Cartridge Filters (Section 46 6320)		Fil-Trek; Nowata; Parker Hannafin

END OF SECTION 00 4333

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SECTION 00 4336

PROPOSED SUBCONTRACTORS FORM

PART 1 GENERAL

A. List the subcontractors that the Bidder is proposing. As a minimum, indicate electrical subcontractor and system integrator.

LIST OF PROPOSED SUBCONTRACTORS

Subcontractor Name and Address		**Service to Be Provided**

END OF SECTION 00 4336

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SECTION 00 4393

BIDDER'S CHECKLIST

DISCLAIMER - This checklist is not intended to relieve the bidder of the responsibility to provide other required documents. Rather, this checklist is offered merely to serve as an aid in assisting in the preparation of the bid. Notice is hereby given that the failure to submit all required documents duly and properly completed including but not limited to all required signatures may result in the rejection of your bid on the basis that the bid is non-responsive.

BID DOCUMENT FORMS (PROVIDED)

☐ Instructions to Bidders, Section 00 2113 (for information only)

☐ Bid Form, Section 00 4113

☐ Bid Security Form, Section 00 4313

☐ Substitution Request Form, Section 00 4325

☐ Proposed Products Form, Section 00 4333

☐ Proposed Subcontractors Form, Section 00 4336

☐ Bidders Qualifications, Section 00 4513

☐ Non-Collusion Affidavit, Section 00 4519

☐ Personal Property Tax Disclosure Affidavit, Section 00 4529

☐ Findings for Recovery Affidavit, Section 00 4539

OHIO EPA/DEFA GOVERNMENT REQUIRED FORMS (PROVIDED)

☐ Contractor EEO Certification, Section 00 4515

☐ DBE FORMS 1A & 1B, Section 00 4515
(to be submitted with bid package OR within two weeks of bid opening)

☐ Certification Regarding Debarment, suspension, & Other Responsibility Matters, Section 00 4515

☐ American Iron & Steel Sign-off Form, Section 00 4515

ADDITIONAL BID DOCUMENTS REQUIRED FROM BIDDER

☐ Surety's Power of Attorney

☐ Certificate of Authorization to do Business in Ohio (if applicable)

END OF SECTION 00 4393

SECTION 00 4513

BIDDER'S QUALIFICATIONS

At the time of bid, the bidder is required to provide detailed information on the form herein (or referenced and attached hereto) as evidence of the bidder's responsibility, experience, skill, and financial capacity to complete this contract in the time allotted. This information will be used by the owner to determine if the proposal is the lowest responsible and responsive bid. The Owner may make related investigations to determine the ability of the bidder to perform the work. The bidder shall furnish to the Owner or its representative, in a timely manner, all such information and data as the Owner may request for this purpose, which may include a financial statement.

1. General Information

Name: _____
Address: _____

Names, Titles, and Years of Experience of Company Officers and Key Supervisory Personnel:
_____
_____
_____
_____
_____
_____
_____
Address for Administration of this Contract: _____
_____
_____
Years in Business as a Contractor: _____
Former Names of the Organization: _____
_____
_____
Certification of legal qualifications to do business at the project site.
_____
Bank References: _____
_____
_____
Surety for this Project: _____
Name of Bonding Company: _____
Name and Address of Agent: _____
_____
_____

Major equipment owned and available to be used on this Project: _____
_____
_____
_____
_____
_____
Major equipment to be rented for use on this Project: _____
_____
_____
_____

2. Provide the following information for similar projects completed within the last 5 years, within a 500-mile radius of the project site (add sheets if necessary). A similar project shall be defined as a water treatment facility with similar size and complexity.

A. Owner: _____
_____
_____
Project: _____
_____
_____
_____
Original Completion Date:
_____

Contact Person and Phone No.:
_____
_____

Original Contract Amount:
_____

Final Contract Amount:
_____

Final Completion Date: _____

B. Owner: _____
_____
_____
Project: _____
_____
_____
_____
Original Completion Date:
_____

Contact Person and Phone No.:
_____
_____

Original Contract Amount:
_____

Final Contract Amount:
_____

Final Completion Date: _____

C. Owner: _____ Contact Person and Phone No.:
_____ _____
_____ _____
Project: _____
_____ Original Contract Amount:
_____ _____
_____
Original Completion Date: Final Contract Amount:
_____ _____

Final Completion Date: _____

D. Owner: _____ Contact Person and Phone No.:
_____ _____
_____ _____
Project: _____
_____ Original Contract Amount:
_____ _____
_____
Original Completion Date: Final Contract Amount:
_____ _____

Final Completion Date: _____

E. Additional Sheets

3. Provide the following information for any similar projects within a 500-mile radius of the project site that are currently under construction (add sheets if necessary). A similar project shall be defined as a water treatment facility with similar size and compexity:

A. Owner: _____ Contact Person and Phone No.:
_____ _____
_____ _____
Project: _____ Original Contract Amount:
_____ _____
_____

Estimated Final Completion Date: _____

B. Owner: _____ Contact Person and Phone No.:
_____ _____
_____ _____

Project: _____ Original Contract Amount:
_____ _____
_____

Estimated Final Completion Date: _____

C. Owner: _____ Contact Person and Phone No.:
_____ _____
_____ _____

Project: _____ Original Contract Amount:
_____ _____
_____

Estimated Final Completion Date: _____

D. Owner: _____ Contact Person and Phone No.:
_____ _____
_____ _____

Project: _____ Original Contract Amount:
_____ _____
_____

Estimated Final Completion Date: _____

E. Additional Sheets

END OF SECTION 00 4513

SECTION 00 4515

OEPA WSRLA PROGRAM REQUIREMENTS

PART 1 GENERAL

1.1 OHIO ENVIRONMENTAL PROTECTION AGENCY (OEPA) – WATER SUPPLY REVOLVING LOAN ACCOUNT (WSRLA)

A. The contract work described in the Contract Documents is being funded in part with loan and loan forgiveness funds from the OEPA WSRLA Program. All requirements of the OEPA WSRLA Program must be followed and complied with by all bidders and the successful contractor.

1.2 CONTRACTOR'S REQUIREMENTS

A. The following requirements are included in the Contract for the work and are a part thereof:
   1. Contractor Equal Employment Opportunity Certification (2 pages)
   2. Certification Regarding Debarment, Suspension, and Other Responsibility Matters Form (2 pages)
   3. Certification Regarding Debarment, Suspension, and Other Responsibility Matters Instructions (1 page)
   4. Disadvantaged Business Enterprises (DBE) Utilization (5 pages)
   5. Form 6100-3: DBEP Indiv. DBE Subsonctractor Proposed Performance Form (2 pages)
   6. Form 6100-4: DBEP DBE Subcontractor Utilization Summary (1 page)
   7. Form 6100-2: DBEP DBE Subcontractor Actual Participation Form (2 pages)
   8. Form 5700-52A: USEPA MBE/WBE Utilization Under Federal Grants, Coopertiave Agreements, and Interagency Agreements (2 pages)
   9. Form 5700-52A: Instructions (3 pages)
   10. Davis-Bacon Wage Rate Requirements (10 pages)
   11. Violating Facilities Clause (1 page)
   12. Requirement for Utilization of Small Businesses in Rural Areas (SBRA) (1 page)
   13. Insurance Provisions (2 pages)
   14. Materials Testing (1 page)
   15. Continuous Treatment Provisions (1 page)
   16. WPCLF/WSRLA Change Order (2 pages)
   17. Local Protest Procedure (1 page)
   18. Basis and Method for Award (2 pages)
   19. Payment Methods (2 pages)
   20. WPCLF Contract Documents Review (1 page)
   21. Bid Package Submittals (1 page)
   22. American Iron & Steel Provisions (20 pages)
   23. American Iron & Steel Acknowledgement (1 page)
   24. American Iron & Steel Certification Form (1 page)

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 4515

Contract Document Provisions

The following contract requirements and forms are to be included in the construction contract documents. Completed copies of the forms are to be submitted to Ohio EPA within one week after bids are received, or sooner dependent on your individual project schedule. Bid packages for WPCLF projects should be submitted to DEFA in the central office while bid packages for WSRLA projects should be submitted to the appropriate DDAGW district office.

Equal Employment Opportunity (EEO) Requirements

The Contractor's EEO Certification Form must be (1) included in the contract documents and (2) referenced in the Instructions to Bidders, informing bidders that the form must be completed and submitted with their bid.
NOTE: If the loan applicant has its own EEO requirements, local procedures and forms may be substituted for the EPA form.

Debarment

The Certification Regarding Debarment, Suspension, and Other Responsibility Matters must be (1) included in the contract documents and (2) referenced in the Instructions to Bidders, informing bidders that the form must be completed and submitted with their bid.

Disadvantaged Business Enterprises (DBE) Utilization

The DBE Specification language and instructions to the bidders and Forms 6100-3, 6100-4 and 6100-2 must be (1) included in the contract documents and (2) referenced in the Instructions to Bidders, informing bidders that the forms must be completed and submitted with their bid.
NOTE: If the loan applicant has its own DBE requirements or if other funding programs with potentially competing DBE requirements are participating in the project funding, please contact Ohio EPA – DEFA for specific instructions regarding the DBE requirements.

Davis-Bacon wage rate requirements

The contract documents must include language that requires contractors and subcontractors to pay wages at rates not less than those prevailing on similar projects within the area as determined by the US Secretary of Labor. In addition, the loan recipient will be required to conduct wage interviews and monitor payroll for compliance.

American Iron and Steel requirements

All treatment works projects funded by a WPCLF assistance agreement and all public water system projects funded by a WSRLA assistance agreement are required to comply with American Iron and Steel (AIS) requirements. The acknowledgement form must be included in the contract documents. The acknowledgement form should be signed by the contractor and submitted with the final bid package. It is recommended that the AIS guidance document and questions and answers document be included in the contract documents.

The following contract requirements are to be included in the construction contract documents, but are not required to be submitted to Ohio EPA for contract endorsement.

Violating Facilities Clause

Language prohibiting this use of equipment or services from anyone on the EPA List of Violating Facilities must be included in the contract documents.

Small Businesses in Rural Areas (SBRA)

Language encouraging the participation of small businesses in rural areas should be included in the contract documents.

Insurance Provisions

Section 3.5 of the WPCLF/WSRLA Loan Agreement contains specific requirements regarding insurance for all contractors and all subcontractors for the life of the contract. These insurance requirements must be reflected in the contract documents. Adjust the language as needed to meet the specifics of the construction project while still meeting the provisions of the Loan Agreement.

Materials Testing

In addition to the details included with specific equipment testing in the specifications, there should be an overall statement regarding testing for the project. Adjust the language as needed to meet the specifics of the construction project.

Continuous Treatment Provisions

It is important that construction activities not result in any temporary violations of Drinking Water or NPDES permit requirements (for permitted facilities). Construction activities should interrupt wastewater service to the individual resident as little as possible. For drinking water projects, it is important that construction activities not result in any disruption of service. The example language is intended for construction work occurring at an existing drinking water plant or a WWTP and must be adjusted to meet the specifics of the construction project.

WPCLF/WSRLA Change Order Form

All change orders for the construction project must be executed on the WPCLF/WSRLA change order form. The form must be (1) included in the contract documents and (2) the instructions referenced in the Contract Documents.

The following contract requirements are provided in Ohio Revised Code (ORC). Some loan applicants have local requirements that supersede ORC provisions for competitive bidding, and these local requirements can be applied instead of ORC, except for those requirements specified in the WPCLF/WSRLA loan agreements.

Bid Guarantee

The requirements for a bid guarantee (which can be a bond or a certified check, cashier's check, or letter of credit) are covered in ORC 153.54.

Payment and Performance Bonds

The requirements for a Payment and Performance Bond are covered in ORC 153.54 and Section 3.4 of the WPCLF/WSRLA Loan Agreements.

Payment Retention

The requirement for payment retainage is provided in ORC153.12. Details on how the escrow account that holds the retainage are provided in ORC 153.13. Further details on how and when to pay for materials delivered and installed are provided in ORC 153.14.

Completion Time

The contract documents must state the length of the contract time per ORC 153.19. The dates for Initiation of Operation and Project Completion are specified in the WPCLF/WSRLA Loan Agreements, and need to coincide with the specified contract time.

The following are contract provisions to consider, but are not required. The language provided for each are samples only and must be adjusted to reflect the specifics of the project and local needs.

Local Protest Procedure

Some statement as to when a valid protest must be filed, in what form it must be filed and who it must be filed with should be included. ORC 153.12 has some default procedures for handling disputes. If the owner wants more control than provided in ORC, a procedure needs to be spelled out in the Contract Documents.

Basis and Method for Award

The contract documents should include some language that clearly states what the Owner will consider when determining the successful bidder and to provide a clear basis for the Owner when they have a need to reject the low bidder and go with a different bidder.

Payment Methods

To minimize uncertainty and arguments that can slow down the progress of construction it is useful to provide language stating how and when the Contractor will get paid. In addition to ORC and other local requirements, the involvement of public funding Agencies such as the WPCLF, WSRLA, Ohio Public Works Commission and Community Development Block Grant impact the process and timing for payments.

Contract Documents Review

Whenever possible, all of the provisions listed above must be included in the contract documents for the project prior to advertisement for bids. Ohio EPA's review for these contract provisions will occur as part of our normal detail plans and specifications review. The bidding documents are to be submitted to Ohio EPA for review regardless of whether a Permit to Install or a Plan Approval is required for the project.

After bidding has started:

In those cases when WPCLF or WSRLA funding is being requested after advertisement for bids has started, add all missing contract provisions, forms, and requirements via addendum.

After bids have been opened but before contracts have been signed:

If the bid advertisement period is over and bids have been opened, but the construction contract have not been signed yet, provide a draft contract change order which would be used to incorporate all missing contract provisions, forms, and requirements into the contract. This should be done in consultation with local legal council to address any potential bid protest concerns.

Construction contracts have already been signed:

If the construction contract has already been signed, a contract change order must be executed incorporating all missing contract provisions, forms, and requirements into the contract.

A Contract Documents Review checklist is provided here to help ensure that all requirements are included and to help expedite Ohio EPA's review of your documents.

Bid Package Submittals

Certain documents must be submitted to Ohio EPA within one week after bids are received, or sooner dependent on your individual project schedule. Please look here for a complete list of the required submittals.

NOTE: THE CONTRACT LANGUAGE SAMPLES PROVIDED HEREIN ARE EXAMPLES OF WHAT COULD BE INCLUDED IN ALL CONTRACTS THAT USE WPCLF OR WSRLA FUNDS. OHIO EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THESE CLAUSES WITH RESPECT TO STATE OR LOCAL LAW. IT IS IMPERATIVE THAT ANY PARTY INSERTING THESE CLAUSES INTO A CONTRACT VERIFY THAT THEY ARE LEGAL AND ENFORCEABLE ACCORDING TO STATE AND LOCAL LAWS, REGULATIONS, AND ORDINANCES.

Equal Employment Opportunity (EEO) Requirements

(Required Contract Provision)

The Contractor's EEO Certification Form provided on the following page must be:

(1) included in the contract documents and

(2) referenced in the Instructions to Bidders, informing bidders that the form must be completed and submitted with their bid.

NOTE: If the loan applicant has its own EEO requirements, local procedures and forms may be substituted for the EPA form.

Contractor Equal Employment Opportunity Certification

During the performance of this contract, the undersigned agrees as follows:

1. The undersigned will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The undersigned will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The undersigned agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this equal opportunity (federally assisted construction) clause.

2. The undersigned will, in all solicitations or advertisements for employees placed by or on behalf of the undersigned, state the all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

3. The undersigned will send to each labor union or representative of workers, with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representative of the undersigned's commitment under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. The undersigned will comply with all provisions of Executive Order No. 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

5. The undersigned will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and relevant orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records and accounts by the administering agency of the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

6. In the event of the undersigned's non-compliance with the equal opportunity (federally assisted construction) clause of this contract of with any of the said rules, regulations, or orders, this contract may be canceled, terminated or suspended in whole or in part, and the undersigned may be declared ineligible for further Government contracts of federally assisted construction contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No 11246 of September 24, 1965, or by rules, regulations, or order of the Secretary of Labor, or as provided by law.

7. The undersigned will include this equal opportunity (federally assisted construction) clause in every subcontract or purchase order unless exempted by the rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order No 11246 of September 24, 1965, so that such provision will be binding upon each subcontract or vender. The undersigned will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for non compliance: Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor, as a result of such direction by the administering agency the undersigned may request the United States to enter into such litigation to protect the interest of the United States.

_____

(Signature) (Date)

_____

(Name and Title of Signer, Please type)

_____

(Firm Name)

Debarment Requirements

(Required Contract Provision)

The Certification Regarding Debarment, Suspension, and Other Responsibility Matters form included on the following page must be:

(1) included in the contract documents and

(2) referenced in the Instructions to Bidders, informing bidders that the form must be completed and submitted with their bid.

Certification Regarding Debarment, Suspension, and Other Responsibility Matters
INSTRUCTIONS

Under Executive Order 12549 an individual or organization debarred or excluded from participation in Federal assistance or benefit programs may not receive any assistance award under a Federal program or a subagreement thereunder for $25,000 or more.

Accordingly, each prospective recipient of an EPA grant, loan, or cooperative agreement and any contract or subagreement participant thereunder must complete the attached certification provide an explanation why they cannot. For further details, see the regulation 40 CFR 32.510, Participants' responsibilities.

Go to www.epls.gov to access the Excluded Parties List System (EPLS). The EPLS includes information regarding entities debarred, suspended, proposed for debarment, excluded or disqualified under the nonprocurement common rule, or otherwise declared ineligible from receiving Federal contracts, certain subcontracts, and certain Federal assistance and benefits. This information may include names, addresses, DUNS numbers, Social Security Numbers, Employer Identification Numbers or other Taxpayer Identification Numbers, if available and deemed appropriate and permissible to publish by the agency taking the action.

Where To Submit

The prospective EPA grant, loan, or cooperative agreement recipient must return the signed certification or explanation with its application to Ohio EPA.

A prospective prime contractor must submit a complete certification or explanation to the individual or organization awarding the contract.

Each prospective subcontractor must submit a complete certification or explanation to the prime contractor for the project.

Applicants may reproduce these materials as needed and provide them to their prospective prime contractor, who, in turn, may reproduce and provide them to prospective subcontractors.

Additional copies / assistance may be requested from:

Ohio EPA
Division of Environmental and Financial Assistance
P.O. Box 1049
Columbus, Ohio 43216-1049
(614) 644-2798
www.epa.state.oh.us/defa/

Certification Regarding Debarment, Suspension, and Other Responsibility Matters

The prospective participant certifies to the best of its knowledge and belief that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal of State antitrust statues or commission if embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (b) of this certification;

(d) Have not within a three year period preceding this application / proposal had one or more public transactions (Federal, State, or local) terminated for cause or default; and

(e) Will not utilize a subcontractor or supplier who is unable to certify (a) through (d) above.

I understand that a false statement on this certification may be grounds for rejection of this proposal or termination of the award. In addition, under 18 USC Sec. 1001, a false statement may result in a fine of up to $10,000 or imprisonment for up to 5 years, or both.

_____

Type Name & Title of Authorized Representative

_____

Signature of Authorized Representative

_____

Date

☐ I am unable to certify to the above statements. My explanation is attached.

Disadvantaged Business Enterprises (DBE) Utilization

(Required Contract Provision)

USEPA has a program to encourage the participation of disadvantaged businesses in the construction activities funded by the Clean Water and Drinking Water SRF's. "DBE" is an all inclusive term that includes Minority Business Enterprises (MBE), Women Business Enterprises (WBE), Small Business Enterprises (SBE), Small Business in Rural Areas (SBRA), HUBZone Small Business, Labor Surplus Area Firms (LSAF), and other entities defined as socially and/or economically disadvantaged. While the WPCLF and WSRLA strongly encourage participation by all disadvantaged groups, specific participation goals are negotiated with USEPA only for Minority Business Enterprises and Women's Business Enterprises.

Goals

As a condition of receiving capitalization grants from U.S. EPA for the Water Pollution Control Loan Fund (WPCLF) and the Water Supply Revolving Loan Account (WSRLA), the Ohio EPA negotiates "fair share" Disadvantaged Business Enterprises (DBE) objectives with U.S. EPA. The current negotiated goals for construction related activities are 1.3% of all contracts to MBEs and 1.0% of all contracts to WBEs.

DBE Certification

Under the DBE program, qualified DBE's are those that have been certified as an MBE or WBE. Certifications can be obtained from a federal agency such as the Small Business Administration or the Department of Transportation or by an approved State agency. The Unified Certification Program (UCP) administered by the Ohio Department of Transportation (ODOT) can provide the necessary DBE certifications. Information on the UCP can be found at www.ohioucp.org as well as the ODOT website www.dot.state.oh.us/divisions/equalopportunity/pages/dbe.aspx. Applications for certification by EPA can be found on EPA's Small Business Programs website at www.epa.gov/osbp under the Disadvantaged Business Enterprise Program link. Any questions regarding EPA's certification process should be directed to Teree Henderson of EPA at 202-566-2222.

DBE Qualifications

To qualify for MBE certification, businesses must be 51 percent owned and controlled by a U.S. citizen and Ohio resident belonging to an African American, Native American, Hispanic, or Asian American ethnic group. In addition, the business must be in operation for at least one year prior to submitting an application. For DBE status, a business must be at least 51 percent owned by a socially and economically disadvantaged person who participates in the daily operations of the business. This person must be a woman or of African-American, Hispanic, Native American, Asian American ethnicity.

Program Requirements

To comply with DBE program requirements the WPCLF/WSRLA loan recipient must do the following:

1. Create and maintain a bidder's list (see description below)

2. Include contract conditions applicable to the DBE program in all procurement contracts entered into by the Borrower for all WPCLF and WSRLA projects. These conditions are listed below.
3. Follow, document, and maintain documentation of good faith efforts on the part of prime contractors to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project.
4. Review the Form 6100-3 and 6100-4 submittals provided by bidders on the project for completeness and obtain any additional information necessary to verify the certification status of all proposed subcontractors.
5. Obtain documentation of the good faith efforts of the prime contractor if the prime contractor does not meet the MBE or WBE goal.
6. Obtain a written confirmation from any prime contractor states that they will not meet the MBE and WBE goals because they will not be entering into any agreements for goods or services with any company, firm, joint venture, or individual.
7. Submit the following to the Ohio EPA/DEFA as part of the bid package upon which the WPCLF/WSRLA loan amount is determined:
   - Form 6100-3 from each subcontractor
   - Form 6100-4 from each prime contractor
   - a copy of the Good Faith Efforts documentation from any prime contractors that will not meet the MBE and WBE goals,
   - if any of the prime contractors will not meet the MBE and WBE goals because they will not be entering into any agreements for goods or services with any company, firm, joint venture, or individual, a copy of the written confirmation from that prime contractor
8. Report MBE/WBE accomplishments on Form 5700-52A annually (within 15 days after October 1st).

NOTE: It is up to the WPCLF/WSRLA loan recipient whether or not to require completion and submission of Forms 6100-3 and 6100-4 from all bidders with the bid proposal or to accept completion and submission from the successful bidder(s) only at some time after bids are received. Regardless of whether the forms are completed and submitted with the bids or at some later time once the successful bidders are identified, completed forms are to be submitted to Ohio EPA with the bid package.

To comply with DBE program requirements all prime contractors must do the following:

1. Follow, document, and maintain documentation of their good faith efforts.
2. Complete and submit **Form 6100-4 DBE Subcontractor Utilization Summary** as part of the bid proposal package to the loan recipient.
3. Have its Disadvantaged Business Enterprise subcontractors complete **Form 6100-3 DBE Subcontractor Proposed Performance Form** and submit those as part of the bid proposal package to the loan recipient.
4. Provide **Form 6100-2 DBE Subcontractor Actual Participation Form** to all of its Disadvantaged Business Enterprise subcontractors for completion at the end of the work.
5. During construction, provide the data necessary so that the loan recipient can report MBE/WBE accomplishments on Form 5700-52A annually (within 15 days after October 1st).

Bidders List

The Borrower must create, maintain, and use a bidders list for purposes of soliciting both MBE/WBEs and non-MBE/WBEs during procurement of construction, equipment, supplies, and services. This list shall include:

1. Entity's name with point of contact;
2. Entity's mailing address, telephone number, and e-mail address;
3. The procurement on which the entity bid or quoted, and when; and
4. Entity's status as an MBE/WBE or non-MBE/WBE.

Borrowers that receive less than $250,000 or less in any one fiscal year can be exempt from maintaining a Bidders List.

The Bidders List shall be maintained until the project period has expired and the Borrower is no longer receiving EPA funding. The Bidders List must include all firms that bid on the prime contracts, or bid or gave a quote on subcontracts, including both MBE/WBEs and non-MBE/WBEs.

Required Contract Conditions

The DBE Specification language and instructions to the bidders and Forms 6100-2, 6100-3 and 6100-4 must be included in the contract documents and referenced in the Instructions to Bidders, informing bidders that the forms must be completed and submitted with their bid for all WPCLF and WSRLA projects:

1. The prime contractor must pay its subcontractor for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the owner.
2. The prime contractor must notify the owner in writing prior to the termination of any Disadvantage Business Enterprise subcontractor for convenience by the prime contractor.
3. If a Disadvantage Business Enterprise contractor fails to complete work under the subcontract for any reason, the prime contractor must employ the six Good Faith Efforts (listed below) if soliciting a replacement contractor.
4. The prime contractor must employ the six Good Faith Efforts even if the prime contractor has achieved its fair share objectives.
5. An owner must ensure that each procurement contract it awards contains the following terms and conditions:

   The contractor shall not discriminate on the basis of race, color, national origin or sex in the performance of this contract. The contractor shall carry out applicable requirements of 40 CFR Part 33 in the award and administration of contracts awarded under EPA financial assistance agreements. Failure by the contractor to carry out these requirements is a material breach of this contract which may result in the termination of this contract or other legally available remedies.

Good Faith Efforts

Borrowers and their prime contractors must follow, document, and maintain documentation of their good faith efforts as listed below to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project by increasing DBE awareness of procurement efforts and outreach.

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities; including DBEs on solicitation lists and soliciting them whenever they are potential sources.
2. Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. This includes, whenever possible, posting solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.
3. Consider in the contracting process whether firms competing for large contracts could be subcontracted with DBEs. This will include dividing total requirements when economically feasible into smaller tasks or quantities to permit participation by DBEs in the competitive process.
4. Encourage contracting with a consortium of DBEs when a contract is too large for one of these firms to handle individually.
5. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.
6. If the prime contractor awards subcontracts, require the prime contractor to take the steps in numbers 1 through 5 above.

DBE Forms

Form 6100-3 – Each prime contractor must have its DBE subcontractors complete **Form 6100-3 DBE Subcontractor Proposed Performance Form**. This form gives the DBE subcontractor the opportunity to report the scope and cost of the subcontract and it should be forwarded to the Prime Contractor along with the DBE's quote. Each subcontractor completes one Form 6100-3. The Borrower must submit all Form 6100-3 forms to the Ohio EPA/DEFA as part of the bid package upon which the WPCLF/WSRLA loan amount is determined.

Form 6100-4 – Each prime contractor must complete and submit **Form 6100-4 DBE Subcontractor Utilization Summary** as part of the prime contractor's bid proposal package to the Borrower. This form summarizes the Prime Contractor's intended use of identified DBE(s) and the estimated dollar amount of each subcontract. Only one Form 6100-4 form is required from each Prime Contractor. The Borrower must submit this form to the Ohio EPA/DEFA as part of the bid package upon which the WPCLF/WSRLA loan amount is determined.

Form 6100-2 - The prime contractor must provide **Form 6100-2 DBE Subcontractor Actual Participation Form** to all of its Disadvantaged Business Enterprise subcontractors.

This form gives the DBE subcontractor the opportunity to describe the work the DBE received from the Prime Contractor, how much the DBE was paid and any other concerns the DBE might have. Disadvantaged Business Enterprise subcontractors must send completed Form 6100-2 directly to the Region 5 DBE Coordinator:

Adrianne M. Callahan, Region 5 MBE/WBE Coordinator
USEPA, Acquisition and Assistance Branch
77 West Jackson Boulevard (MC-10J)
Chicago, IL 60604

This form is completed after the work by the subcontractor is done, and is NOT submitted with the bid package to Ohio EPA.

Reporting During Construction – Form 5700-52A

The purpose of MBE/WBE reporting is to monitor the grant recipient's accomplishments in utilizing MBEs and WBEs; and adherence to the good faith efforts (i.e., outreach to MBEs, WBEs, and other DBEs); and progress in achieving MBE and WBE Goals. During the progress of the construction project, the loan recipient must complete & submit Form 5700-52A annually (**within 15 days after October 1st**). If there were no MBEs or WBEs utilized, or no procurement expenditures of any kind were made during the reporting period, a "negative report" is still required.

Reports are to be sent to:

Becky McKinney Ohio EPA – DEFA
P.O. Box 1049
Columbus, OH 43216-1049
E-mail address: Rebecca.McKinney@epa.ohio.gov
Phone: (614) 644-3636
Fax: (614) 644-3687

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

This form is intended to capture the DBE[1] subcontractor's[2] description of work to be performed and the price of the work submitted to the prime contractor. An EPA Financial Assistance Agreement Recipient must require its prime contractor to have its DBE subcontractors complete this form and include all completed forms in the prime contractors bid or proposal package.

Subcontractor Name	Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.	Email Address	
Prime Contractor Name	Issuing/Funding Entity:	

Contract Item Number	**Description of Work Submitted to the Prime Contractor Involving Construction, Services , Equipment or Supplies**	**Price of Work Submitted to the Prime Contractor**
DBE Certified By: ◯ DOT ◯ SBA ◯ Other: _____	Meets/ exceeds EPA certification standards? ◯ YES ◯ NO ◯ Unknown	

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	**Date**

Subcontractor Signature	Print Name
Title	**Date**

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form

This form is intended to capture the prime contractor's actual and/or anticipated use of identified certified DBE[1] subcontractors[2] and the estimated dollar amount of each subcontract. An EPA Financial Assistance Agreement Recipient must require its prime contractors to complete this form and include it in the bid or proposal package. Prime contractors should also maintain a copy of this form on file.

Prime Contractor Name		Project Name
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.	Email Address	
Issuing/Funding Entity:		

I have identified potential DBE certified subcontractors	___YES	___NO
If yes, please complete the table below. If no, please explain:		

Subcontractor Name/ Company Name	**Company Address/ Phone/ Email**	**Est. Dollar Amt.**	**Currently DBE Certified?**

Continue on back if needed

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	**Date**

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

An EPA Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE[1] subcontractor[2] the opportunity to describe work received and/or report any concerns regarding the EPA-funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the EPA DBE Coordinator at any time during the project period of performance.

Subcontractor Name	Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.	Email Address	
Prime Contractor Name	Issuing/Funding Entity:	

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services , Equipment or Supplies	Amount Received by Prime Contractor

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

Please use the space below to report any concerns regarding the above EPA-funded project:

Subcontractor Signature	Print Name
Title	**Date**

OMB CONTROL NO. 2030-0020
APPROVED: 06/30/2014
APPROVAL EXPIRES: 06/30/2017

U.S. ENVIRONMENTAL PROTECTION AGENCY
MBE/WBE UTILIZATION UNDER FEDERAL GRANTS AND COOPERATIVE AGREEMENTS

PART I. (Reports are required even if no procurements are made during the reporting period.)

1A. FEDERAL FISCAL YEAR (Oct. 1-Sep 30) 20_____	1B. REPORTING PERIOD (Check ALL appropriate boxes) ☐ 1st (Oct-Dec) ☐ 2nd (Jan-Mar) ☐ 3rd (Apr-Jun) ☐ 4th (Jul-Sep) ☐ Semi-Annual (Oct-Mar) ☐ Semi-Annual (Apr-Sep) ☐ Annual ☐ Check if this is the last report for the project (Project completed).
1C. REVISION OF A PRIOR REPORT? Y or N Year: _____ Quarter: _____	BRIEFLY DESCRIBE THE REVISIONS YOU ARE MAKING:

2A. EPA FINANCIAL ASSISTANCE OFFICE ADDRESS (ATTN: DBE Coordinator)		3A. RECIPIENT NAME AND ADDRESS	
2B. EPA DBE COORDINATOR Name: E-mail:	2C. PHONE: Fax:	3B. RECIPIENT REPORTING CONTACT: Name: E-mail:	3C. PHONE: Fax:
4A. FINANCIAL ASSISTANCE AGREEMENT ID NUMBER (SRF State Recipients, refer to Instructions for Completion of blocks 4A, 5A and 5C.)		4B. FEDERAL FINANCIAL ASSISTANCE PROGRAM TITLE or CFDA NUMBER:	

5A. TOTAL ASSISTANCE AGREEMENT AMOUNT (SRF State Recipients, refer to Instructions for Completion of blocks 4A, 5A and 5C.) EPA Share: $_____ Recipient Share: $_____	5B. If NO procurement and NO accomplishments were made this reporting period (by the recipients, sub-recipients, loan recipients, and prime contractors), **CHECK** and **SKIP** to Block No. 7. (Procurements are all expenditures through contract, order, purchase, lease or barter of supplies, equipment, construction, or services needed to complete Federal assistance programs. Accomplishments, in this context, are procurements made with MBEs and/or WBEs. ☐

5C. Total Procurements This Reporting Period
(Only include amount not reported in any prior reporting period)

Total Procurement Amount $_____(Include total dollar values awarded by recipient, sub-recipients and SRF loan recipients, **including MBE/WBE expenditures.**)

5D.
Were sub-awards issued under this assistance agreement? Yes ☐ No ☐ Were contracts issued under this assistance agreement ? Yes ☐ No ☐

5E. MBE/WBE Accomplishments This Reporting Period

Actual MBE/WBE Procurement Accomplished:
(Include total dollar values awarded by recipient, sub-recipients, SRF loan recipients and Prime Contractors.)

	Construction	Equipment	Services	Supplies	Total
$MBE:					
$WBE:					

6. COMMENTS: (If no MBE/WBE procurements were accomplished during the reporting period, please explain what steps you are taking to achieve the MBE/WBE Program requirements specified in the terms and conditions of the Assistance Agreement.)

7. NAME OF RECIPIENT'S AUTHORIZED REPRESENTATIVE	TITLE
8. SIGNATURE OF RECIPIENT'S AUTHORIZED REPRESENTATIVE	DATE

PART II. **MBE/WBE PROCUREMENTS MADE DURING REPORTING PERIOD**

EPA Financial Assistance Agreement Number: _____

1. Procurement Made By			2. Business Enterprise		3. $ Value of Procurement	4. Date of Procurement MM/DD/YY	5. Type of Product or Services[A] (Enter Code)	6. Name/Address/Phone Number of MBE/WBE Contractor or Vendor
Recipient	Sub-Recipient and/or SRF Loan Recipient	Prime	Minority	Women				

Type of product or service codes:

1 = Construction 2 = Supplies 3 = Services 4 = Equipment

Note: Refer to Terms and conditions of your Assistance Agreement to determine the frequency of reporting. Recipients are required to submit MBE/WBE reports to EPA beginning with the Federal fiscal year quarter the recipients receive the award, continuing until the project is completed.

Instructions:

A. General Instructions:

MBE/WBE utilization is based on 40 CFR Part 33. EPA Form 5700-52A must be completed by recipients of Federal grants, cooperative agreements, or other Federal financial assistance which involve procurement of supplies, equipment, construction or services to accomplish Federal assistance programs.

Recipients are required to report 30 days after the end of each federal fiscal quarter, semiannually, or annually, per the terms and conditions of the financial assistance agreement.

	Quarterly Reporting Due Date	Semiannual Reporting Due Date	Annual Reporting Due Date
Agreements awarded prior to May 27, 2008	January 30, April 30, July 30, October 30	N/A	October 30
Agreements awarded on or after May 27, 2008	N/A	April 30, October 30	October 30

MBE/WBE program requirements, including reporting, are material terms and conditions of the financial assistance agreement.

B. Definitions:

Procurement is the acquisition through contract, order, purchase, lease or barter of supplies, equipment, construction or services needed to accomplish Federal assistance programs.

A ***contract*** is a written agreement between an EPA recipient and another party (also considered "prime contracts") and any lower tier agreement (also considered "subcontracts") for equipment, services, supplies, or construction necessary to complete the project. This definition excludes written agreements with another public agency. This definition includes personal and professional services, agreements with consultants, and purchase orders.

A ***minority business enterprise*** **(MBE)** is a business concern that is (1) at least 51 percent owned by one or more minority individuals, or, in the case of a publicly owned business, at least 51 percent of the stock is owned by one or more minority individuals; and (2) whose daily business operations are managed and directed by one or more of the minority owners. In order to qualify and participate as an MBE prime or subcontractor for EPA recipients under EPA's DBE Program, an entity must be properly certified as required by 40 CFR Part 33, Subpart B.

U.S. citizenship is required. Recipients shall presume that minority individuals include Black Americans, Hispanic Americans, Native Americans, Asian Pacific Americans, or other groups whose members are found to be disadvantaged by the Small Business Act or by the Secretary of Commerce under section 5 of Executive order 11625. The reporting contact at EPA can provide additional information.

A ***woman business enterprise*** **(WBE)** is a business concern that is, (1) at least 51 percent owned by one or more women, or, in the case of a publicly owned business, at least 51 percent of the stock is owned by one or more women and (2) whose daily business operations are managed and directed by one or more of the women owners. In order to qualify and participate as a WBE prime or subcontractor for EPA recipients under EPA's DBE Program, an entity must be properly certified as required by 40 CFR Part 33, Subpart B.

Business firms which are 51 percent owned by minorities or women, but are in fact managed and operated by non-minority individuals do not qualify for meeting MBE/WBE procurement goals. U.S. Citizenship is required.

Good Faith Efforts

A recipient is required to make the following good faith efforts whenever procuring construction, equipment, services, and supplies under an EPA financial assistance agreement. These good faith efforts for utilizing MBEs and WBEs must be documented. Such documentation is subject to EPA review upon request:

1. Include of MBEs/WBEs on solicitation lists.
2. Assure that MBEs/WBEs are solicited once they are identified.
3. Divide total requirements into smaller tasks to permit maximum MBE/WBE participation, where feasible.
4. Establish delivery schedules which will encourage MBE/WBE participation, where feasible.
5. Encourage use of the services of the U.S. Department of Commerce's Minority Business Development Agency (MBDA) and the U.S. Small Business Administration to identify MBEs/WBEs.

6. Require that each party to a subgrant, subagreement, or contract award take the good faith efforts outlined here.

C. Instructions for Part I:

1a. Specify Federal fiscal year this report covers. The Federal fiscal year runs from October 1st through September 30th (**e.g. November 29, 2010 falls within Federal fiscal year 2011**)

1b. Check applicable reporting box, quarterly, semiannually, or annually. Also indicate if this is the last report for the project.

1c. Indicate if this is a revision to a previous year, half-year, or quarter, and provide a brief description of the revision you are making.

2a-c. Please refer to your financial assistance agreement for the mailing address of the EPA financial assistance office for your agreement.

The "EPA DBE Reporting Contact" is the DBE Coordinator for the EPA Region from which your financial assistance agreement was originated. For a list of DBE Coordinators please refer to the EPA OSBP website at www.epa.gov/osbp. Click on "Regional Contacts" for the name of your coordinator.

3a-c. Identify the agency, state authority, university or other organization which is the recipient of the Federal financial assistance and the person to contact concerning this report.

4a. Provide the Assistance Agreement number assigned by EPA. A separate report must be submitted for each Assistance Agreement.

***For SRF recipients**: In box 4a list numbers for ALL OPEN Assistance Agreements being reported on this form. Please note that although the New DBE Rule (which took effect May 27, 2008) revised the reporting frequency requirements from quarterly to semiannually, that change only applies to agreements awarded AFTER the New DBE Rule took effect. Therefore, SRF recipients may either continue to report activity for all Agreements on one form on a quarterly basis until the last award that was made prior to the New DBE Rule has been closed out; OR, the recipient may split the submission of SRF reports into quarterly reports for Agreements awarded prior the New DBE Rule, and semiannually for the awards made after the New DBE Rule.

4b. Refer back to Assistance Agreement document for this information.

5a. Provide the total amount of the Assistance Agreement which includes Federal funds plus recipient matching funds and funds from other sources.

***For SRF recipients only**: SRF recipients will not enter an amount in 5a. Please leave 5a blank.

5b. Self-explanatory.

5c. Provide the total dollar amount of **ALL** procurements awarded this reporting period by the recipient, sub-recipients, and SRF loan recipients, **including** MBE/WBE expenditures. For example: Actual dollars for procurement from the procuring office; actual contracts let from the contracts office; actual goods, services, supplies, etc., from other sources including the central purchasing/ procurement centers).

***NOTE**: To prevent double counting on line 5C, if any amount on 5E is for a subcontract and the prime contract has already been included on Line 5C in a prior reporting period, then report the amount going to MBE or WBE subcontractor on line 5E, but exclude the amount from Line 5C. To include the amount on 5C again would result in double counting because the prime contract, which includes the subcontract, would have already been reported.

5d. State whether or not sub-awards and/or subcontracts have been issued under the assistance agreement by indicating "yes" or "no".

5e. Where requested, also provide the total dollar amount of all MBE/WBE procurement awarded during this reporting period by the recipient, sub-recipients, SRF loan recipients, and prime contractors in the categories of construction, equipment, services and supplies. These amounts include Federal funds plus recipient matching funds and funds from other sources.

***For SRF recipients only**: In 5c please enter the total procurement amount for the quarter, or semiannual period, under all of your SRF Assistance Agreements. The figure reported in this section is **not** directly tied to an individual Assistance Agreement identification number. **(SRF state recipients report state procurements in this section)**

6. If there were no MBE/WBE accomplishments this reporting period, please briefly explain what

specific steps you are taking to achieve the MBE/WBE requirements specified in the terms and conditions of the Assistance Agreement.

7. Name and title of official administrator or designated reporting official.

8. Signature, month, day, and year report submitted.

D. Instructions for Part II:

For each MBE/WBE procurement made under this assistance agreement during the reporting period, provide the following information:

1. Check whether this procurement was made by the recipient, sub-recipient/SRF loan recipient, or the prime contractor.

2. Check either the MBE or WBE column. If a firm is both an MBE and WBE, the recipient may choose to count the entire procurement towards EITHER its MBE or WBE accomplishments. The recipient may also divide the total amount of the procurement (using any ratio it so chooses) and count those divided amounts toward its MBE and WBE accomplishments. If the recipient chooses to divide the procurement amount and count portions toward its MBE and WBE accomplishments, please state the appropriate amounts under the MBE and WBE columns on the form. **The combined MBE and WBE amounts for that MBE/WBE contractor must not exceed the "Value of the Procurement" reported in column #3**

3. Dollar value of procurement.

4. Date of procurement, shown as month, day, year. Date of procurement is defined as the date the contract or procurement was awarded, **not** the date the contractor received payment under the awarded contract or procurement, unless payment occurred on the date of award. **(Where direct purchasing is the procurement method, the date of procurement is the date the purchase was made)**

5. Using codes at the bottom of the form, identify type of product or service acquired through this procurement (e.g., enter 1 if construction, 2 if supplies, etc).

6. Name, address, and telephone number of MBE/WBE firm.

**This data is requested to comply with provisions mandated by: statute or regulations and 33); OMB Circulars; or added by EPA to ensure sound and effective assistance management. Accurate, complete data are required to obtain funding, while no pledge of confidentiality is provided.

The public reporting and recording burden for this collection of information is estimated to average l hour per response annually. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclosure or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, OPPE Regulatory Information Division, U.S. Environmental Protection Agency (2136), 1200 Pennsylvania Avenue, NW, Washington, D.C. 20460. Include the OMB Control number in any correspondence. Do not send the completed form to this address.

Davis-Bacon Wage Rate Requirements

(required contract provision)

Background and Applicability

On October 30, 2009, P.L. 111-88, "Making appropriations for the Department of the Interior, environment, and related agencies for the fiscal year ending September 30, 2010, and for other purposes," was enacted. This law provides appropriations for both the Clean Water State Revolving Fund (CWSRF) and the Drinking Water State Revolving Fund (DWSRF) for Fiscal Year 2010, while adding new requirements to these already existing programs. One new requirement requires the application of Davis-Bacon Act requirements.

Application of the Davis-Bacon Act requirements extend not only to assistance agreements funded with Fiscal Year 2010 appropriations, but to all assistance agreements executed on or after October 30, 2009, whether the source of the funding is prior year's appropriations, state match, bond proceeds, interest earnings, principal repayments, or any other source of funding so long as the project is financed by an SRF assistance agreement. If a project began construction prior to October 30, 2009, but is financed or refinanced through an assistance agreement executed on or after October 30, 2009, Davis-Bacon Act requirements will apply to all construction that occurs on or after October 30, 2009, through completion of construction.

Ohio EPA Responsibilities

With respect to the Water Pollution Control Loan Fund (WPCLF) and Water Supply Revolving Loan Account (WSRLA) revolving funds, EPA provides capitalization grants to each State which in turn provides funding assistance to eligible recipients within the State. Typically, the assistance recipients are municipal or other local governmental entities that manage the funds. Occasionally, the assistance recipients may be a private for profit or not for profit entity. Although EPA and the State are responsible for ensuring assistance recipients incorporate the wage rate requirements set forth herein as part of contracts for WPCLF and WSRLA funding, the assistance recipient has the primary responsibility to maintain payroll records and for compliance with Davis-Bacon Act requirements as described below.

Municipal Or Other Local Governmental Entities Recipient's Responsibilities

The following is intended to help assistance recipients understand and meet their obligations related to Davis-Bacon (DB). Each assistance recipients should, however, review the contract/subcontract requirements that are set forth later in this document for a more full understanding of DB obligations.

Prior to advertising for bids:

> Obtain the wage determination for the locality in which a covered activity subject to DB will take place from the Department of Labor (DOL) at www.wdol.gov.

> Incorporate these wage determinations into the request for bids.

> Include the required contract provisions (see below) into the contract documents.

> Require prime contracts to include provisions that subcontractors follow the wage determination incorporated into the prime contract.

During the advertisement period:

> Monitor www.wdol.gov on a weekly basis to ensure that the wage determination contained in the request for bids remains current.

> If DOL modifies the DB wage determination more than 10 days prior to the bid opening, issue an addendum reflecting the modification.

> If DOL modifies or supersedes the DB wage determination less than 10 days prior to bid opening and you cannot issue an addendum for the change, you must request a finding from Ohio EPA that there is not reasonable time to notify interested contractors of the modification of the wage determination. The Ohio EPA will give you a report of its findings.

After opening bids:

> If the contract(s) aren't awarded within 90 days of the bid opening you must monitor www.wdol.gov on a weekly basis to ensure that wage determinations used in the bids remain current.

> If the contract(s) aren't awarded within 90 days of the bid opening, any modifications or supersedes that DOL makes to the wage determination must be incorporated into the contract unless (1) you request an extension from Ohio EPA AND (2) Ohio EPA obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv).

After contracts are signed and during construction:

> Review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.

> DOL may issue a revised wage determination applicable to one or all of your contracts after the award of the contract or execution of the change order which incorporated DB requirements into the contract if DOL determines that you have failed to incorporate a wage determination or have used a wage determination that clearly does not apply to the contract. If this occurs, you shall either terminate the contract or change order and rebid the contract OR incorporate DOL's wage determination retroactive to the beginning of the contract by change order. The contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.

> Periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. You must use Standard Form 1445 or equivalent documentation to memorialize the interviews.

> Establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, you must:

- conduct all interviews in confidence.
- conduct interviews with a representative group of covered employees within two weeks of each contractor or subcontractor's submission of its initial weekly payroll data and two weeks prior to the estimated completion date for the contract or subcontract.
- conduct more frequent interviews if the initial interviews or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB.
- immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements.

> Periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. You must:

- establish and follow a spot check schedule based on your assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract.
- spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract at a minimum.
- conduct more frequent spot checks if the initial spot check or other information indicates that there

is a risk that the contractor or subcontractor is not complying with DB.

• during the examinations, verify evidence of fringe benefit plans and payments thereunder by contractors and subcontractors who claim credit for fringe benefit contributions.

> Periodically review contractors' and subcontractors' use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the DOL or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews.

> Immediately report potential violations of the DB prevailing wage requirements to Andrew Lausted at EPA Region V at 312-886-0189 and to the appropriate DOL Wage and Hour District Office listed at http://www.dol.gov/esa/contacts/whd/america2.htm.

If contracts have already been signed and DB requirements need to be incorporated:

> If contracts have already been signed prior to WPCLF/WSRLA funding being provided, you must issue a change order, task order, work assignment or similar legally binding instrument and incorporate the appropriate DOL wage determination from www.wdol.gov as well as the required contract provisions into the contract(s).

> Initiate the contractor and subcontractor review and wage interview requirements as described above and provided in the **Contract And Subcontract Provisions**.

Private For Profit Or Not For Profit (Non-Governmental) Entities Recipient's Responsibilities

The requirements, responsibilities and contract provisions for Private For Profit or Not For Profit Entities (Non-Governmental Entities) is exactly the same as for Municipal Or Other Local Governmental Entities EXCEPT for the following:

Prior to advertising for bids:

> Obtain the proposed wage determinations for specific localities from www.wdol.gov.

> Submit the wage determination to Ohio EPA for approval prior to inserting the wage determination into the solicitation unless subsequently directed otherwise by Ohio EPA.

Contract And Subcontract Provisions For Contracts In Excess Of $2,000

The following language must be included in full in any contract in excess of $2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part with WPCLF or WSRLA funds and which is subject to the labor standards provisions of any of the acts listed in §5.1:

NOTE: Modify the first sentence to include the name of the WPCLF/WSRLA funding recipient prior to including these provisions in the contract documents.

Wage Rate Requirements

As used in these provisions "subrecipient" means_____(fill in WPCLF/WSRLA funding recipient name here).

(a) The following applies to any contract in excess of $2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public

work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1.

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's web site, www.wdol.gov.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The EPA award official shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the subrecipient(s) to the State award official. The State award official will transmit the report, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department

of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the questions, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the

plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the subgrant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees --

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe

benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may by appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

Contract Provision For Contracts In Excess Of $100,000 And Subject To The Overtime Provisions Of The Contract Work Hours And Safety Standards Act

The following language must be included in full in any contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These provisions are to be included in addition to the provisions for contracts in excess of $2,000. As used in these paragraphs, the terms laborers and mechanics include watchmen and guards.

(b) Contract Work Hours and Safety Standards Act. The following applies to any contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. As used in these paragraphs, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

Contract Provision For Contracts In Excess Of $100,000 Subject ONLY To The Contract Work Hours And Safety Standards Act

In addition to the provisions for contracts in excess of $2,000, for any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, you must insert clauses requiring:

(c) The following applies to any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1.

The contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid.

The records shall be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the Ohio EPA, EPA and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

AMERICAN IRON AND STEEL ACKNOWLEDGEMENT

The Contractor acknowledges to and for the benefit of the City of _____ ("Purchaser") and the State of Ohio (the "State") that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as "American Iron and Steel;" that requires all of the iron and steel products used in the project to be produced in the United States ("American Iron and Steel Requirement") including iron and steel products provided by the Contactor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney's fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

_____ _____

Signature Date

_____

Name and Title of Authorized Signatory, Please Print or Type

_____

Bidder's Firm

☐ Check here if the WPCLF or WSRLA applicant will be requesting an individual waiver for non-American made iron and steel products. Please note that the waiver box does not need to be marked for nationwide waivers.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 20 2014

OFFICE OF WATER

MEMORANDUM

SUBJECT: Implementation of American Iron and Steel provisions of P.L. 113-76, Consolidated Appropriations Act, 2014

FROM: Andrew D. Sawyers, Director
Office of Wastewater Management (4201M)

Peter C. Grevatt, Director
Office of Ground Water and Drinking Water (4601M)

TO: Water Management Division Directors
Regions I - X

P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), includes an "American Iron and Steel (AIS)" requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use iron and steel products that are produced in the United States for projects for the construction, alteration, maintenance, or repair of a public water system or treatment works if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Federal Fiscal Year 2014.

Section 436 also sets forth certain circumstances under which EPA may waive the AIS requirement. Furthermore, the Act specifically exempts projects where engineering plans and specifications were approved by a State agency prior to January 17, 2014.

The approach described below explains how EPA will implement the AIS requirement. The first section is in the form of questions and answers that address the types of projects that must comply with the AIS requirement, the types of products covered by the AIS requirement, and compliance. The second section is a step-by-step process for requesting waivers and the circumstances under which waivers may be granted.

Implementation

The Act states:

Sec. 436. (a)(1) None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j–12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.

(2) In this section, the term ''iron and steel products'' means the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and construction materials.

(b) Subsection (a) shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency (in this section referred to as the ''Administrator'') finds that—

(1) applying subsection (a) would be inconsistent with the public interest;

(2) iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

(3) inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

(c) If the Administrator receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Web site of the Environmental Protection Agency.

(d) This section shall be applied in a manner consistent with United States obligations under international agreements.

(e) The Administrator may retain up to 0.25 percent of the funds appropriated in this Act for the Clean and Drinking Water State Revolving Funds for carrying out

the provisions described in subsection (a)(1) for management and oversight of the requirements of this section.

(f) This section does not apply with respect to a project if a State agency approves the engineering plans and specifications for the project, in that agency's capacity to approve such plans and specifications prior to a project requesting bids, prior to the date of the enactment of this Act.

The following questions and answers provide guidance for implementing and complying with the AIS requirements:

Project Coverage

1) What classes of projects are covered by the AIS requirement?

All treatment works projects funded by a CWSRF assistance agreement, and all public water system projects funded by a DWSRF assistance agreement, from the date of enactment through the end of Federal Fiscal Year 2014, are covered. The AIS requirements apply to the entirety of the project, no matter when construction begins or ends. Additionally, the AIS requirements apply to all parts of the project, no matter the source of funding.

2) Does the AIS requirement apply to nonpoint source projects or national estuary projects?

No. Congress did not include an AIS requirement for nonpoint source and national estuary projects unless the project can also be classified as a 'treatment works' as defined by section 212 of the Clean Water Act.

3) Are any projects for the construction, alteration, maintenance, or repair of a public water system or treatment works excluded from the AIS requirement?

Any project, whether a treatment works project or a public water system project, for which engineering plans and specifications were approved by the responsible state agency prior to January 17, 2014, is excluded from the AIS requirements.

4) What if the project does not have approved engineering plans and specifications but has signed an assistance agreement with a CWSRF or DWSRF program prior to January 17, 2014?

The AIS requirements do not apply to any project for which an assistance agreement was signed prior to January 17, 2014.

5) What if the project does not have approved engineering plans and specifications, but bids were advertised prior to January 17, 2014 and an assistance agreement was signed after January 17, 2014?

If the project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the approval date for purposes of the exemption in section 436(f).

6) What if the assistance agreement that was signed prior to January 17, 2014, only funded a part of the overall project, where the remainder of the project will be funded later with another SRF loan?

If the original assistance agreement funded any construction of the project, the date of the original assistance agreement counts for purposes of the exemption. If the original assistance agreement was only for planning and design, the date of that assistance agreement will count for purposes of the exemption only if there is a written commitment or expectation on the part of the assistance recipient to fund the remainder of the project with SRF funds.

7) What if the assistance agreement that was signed prior to January 17, 2014, funded the first phase of a multi-phase project, where the remaining phases will be funded by SRF assistance in the future?

In such a case, the phases of the project will be considered a single project if all construction necessary to complete the building or work, regardless of the number of contracts or assistance agreements involved, are closely related in purpose, time and place. However, there are many situations in which major construction activities are clearly undertaken in phases that are distinct in purpose, time, or place. In the case of distinct phases, projects with engineering plans and specifications approval or assistance agreements signed prior to January 17, 2014 would be excluded from AIS requirements while those approved/signed on January 17, 2014, or later would be covered by the AIS requirements.

8) What if a project has split funding from a non-SRF source?

Many States intend to fund projects with "split" funding, from the SRF program and from State or other programs. Based on the Act language in section 436, which requires that American iron and steel products be used in any project for the construction, alteration, maintenance, or repair of a public water system or treatment works receiving SRF funding between and including January 17, 2014 and September 30, 2014, any project that is funded in whole or in part with such funds must comply with the AIS requirement. A "project" consists of all construction necessary to complete the building or work regardless of the number of contracts or assistance agreements involved so long as all contracts and assistance agreements awarded are closely related in purpose, time and place. This precludes the intentional splitting of SRF projects into separate and smaller contracts or assistance agreements to avoid AIS coverage on some portion of a larger

project, particularly where the activities are integrally and proximately related to the whole. However, there are many situations in which major construction activities are clearly undertaken in separate phases that are distinct in purpose, time, or place, in which case, separate contracts or assistance agreement for SRF and State or other funding would carry separate requirements.

9) What about refinancing?

If a project began construction, financed from a non-SRF source, prior to January 17, 2014, but is refinanced through an SRF assistance agreement executed on or after January 17, 2014 and prior to October 1, 2014, AIS requirements will apply to all construction that occurs on or after January 17, 2014, through completion of construction, unless, as is likely, engineering plans and specifications were approved by a responsible state agency prior to January 17, 2014. There is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to January 17, 2014.

10) Do the AIS requirements apply to any other EPA programs, besides the SRF program, such as the Tribal Set-aside grants or grants to the Territories and DC?

No, the AIS requirement only applies to funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j–12)

<u>Covered Iron and Steel Products</u>

11) What is an iron or steel product?

For purposes of the CWSRF and DWSRF projects that must comply with the AIS requirement, an iron or steel product is one of the following made primarily of iron or steel that is permanently incorporated into the public water system or treatment works:

Lined or unlined pipes or fittings;
Manhole Covers;
Municipal Castings (defined in more detail below);
Hydrants;
Tanks;
Flanges;
Pipe clamps and restraints;
Valves;
Structural steel (defined in more detail below);
Reinforced precast concrete; and
Construction materials (defined in more detail below).

12) What does the term 'primarily iron or steel' mean?

'Primarily iron or steel' places constraints on the list of products above. For one of the listed products to be considered subject to the AIS requirements, it must be made of greater than 50% iron or steel, measured by cost. The cost should be based on the material costs.

13) Can you provide an example of how to perform a cost determination?

For example, the iron portion of a fire hydrant would likely be the bonnet, body and shoe, and the cost then would include the pouring and casting to create those components. The other material costs would include non-iron and steel internal workings of the fire hydrant (i.e., stem, coupling, valve, seals, etc). However, the assembly of the internal workings into the hydrant body would not be included in this cost calculation. If one of the listed products is not made primarily of iron or steel, United States (US) provenance is not required. An exception to this definition is reinforced precast concrete, which is addressed in a later question.

14) If a product is composed of more than 50% iron or steel, but is not listed in the above list of items, must the item be produced in the US? Alternatively, must the iron or steel in such a product be produced in the US?

The answer to both question is no. Only items on the above list must be produced in the US. Additionally, the iron or steel in a non-listed item can be sourced from outside the US.

15) What is the definition of steel?

Steel means an alloy that includes at least 50 percent iron, between .02 and 2 percent carbon, and may include other elements. Metallic elements such as chromium, nickel, molybdenum, manganese, and silicon may be added during the melting of steel for the purpose of enhancing properties such as corrosion resistance, hardness, or strength. The definition of steel covers carbon steel, alloy steel, stainless steel, tool steel and other specialty steels.

16) What does 'produced in the United States' mean?

Production in the United States of the iron or steel products used in the project requires that all manufacturing processes, including application of coatings, must take place in the United States, with the exception of metallurgical processes involving refinement of steel additives. All manufacturing processes includes processes such as melting, refining, forming, rolling, drawing, finishing, fabricating and coating. Further, if a domestic iron and steel product is taken out of the US for any part of the manufacturing process, it becomes foreign source material. However, raw materials such as iron ore, limestone and iron and steel scrap are not covered by the AIS requirement, and the

material(s), if any, being applied as a coating are similarly not covered. Non-iron or steel components of an iron and steel product may come from non-US sources. For example, for products such as valves and hydrants, the individual non-iron and steel components do not have to be of domestic origin.

17) Are the raw materials used in the production of iron or steel required to come from US sources?

No. Raw materials, such as iron ore, limestone, scrap iron, and scrap steel, can come from non-US sources.

18) If an above listed item is primarily made of iron or steel, but is only at the construction site temporarily, must such an item be produced in the US?

No. Only the above listed products made primarily of iron or steel, permanently incorporated into the project must be produced in the US. For example trench boxes, scaffolding or equipment, which are removed from the project site upon completion of the project, are not required to be made of U.S. Iron or Steel.

19) What is the definition of 'municipal castings'?

Municipal castings are cast iron or steel infrastructure products that are melted and cast. They typically provide access, protection, or housing for components incorporated into utility owned drinking water, storm water, wastewater, and surface infrastructure. They are typically made of grey or ductile iron, or steel. Examples of municipal castings are:

Access Hatches;
Ballast Screen;
Benches (Iron or Steel);
Bollards;
Cast Bases;
Cast Iron Hinged Hatches, Square and Rectangular;
Cast Iron Riser Rings;
Catch Basin Inlet;
Cleanout/Monument Boxes;
Construction Covers and Frames;
Curb and Corner Guards;
Curb Openings;
Detectable Warning Plates;
Downspout Shoes (Boot, Inlet);
Drainage Grates, Frames and Curb Inlets;
Inlets;
Junction Boxes;
Lampposts;
Manhole Covers, Rings and Frames, Risers;

Meter Boxes;
Service Boxes;
Steel Hinged Hatches, Square and Rectangular;
Steel Riser Rings;
Trash receptacles;
Tree Grates;
Tree Guards;
Trench Grates; and
Valve Boxes, Covers and Risers.

20) What is 'structural steel'?

Structural steel is rolled flanged shapes, having at least one dimension of their cross-section three inches or greater, which are used in the construction of bridges, buildings, ships, railroad rolling stock, and for numerous other constructional purposes. Such shapes are designated as wide-flange shapes, standard I-beams, channels, angles, tees and zees. Other shapes include H-piles, sheet piling, tie plates, cross ties, and those for other special purposes.

21) What is a 'construction material' for purposes of the AIS requirement?

Construction materials are those articles, materials, or supplies made primarily of iron and steel, that are permanently incorporated into the project, not including mechanical and/or electrical components, equipment and systems. Some of these products may overlap with what is also considered "structural steel". This includes, but is not limited to, the following products: wire rod, bar, angles, concrete reinforcing bar, wire, wire cloth, wire rope and cables, tubing, framing, joists, trusses, fasteners (i.e., nuts and bolts), welding rods, decking, grating, railings, stairs, access ramps, fire escapes, ladders, wall panels, dome structures, roofing, ductwork, surface drains, cable hanging systems, manhole steps, fencing and fence tubing, guardrails, doors, and stationary screens.

22) What is not considered a 'construction material' for purposes of the AIS requirement?

Mechanical and electrical components, equipment and systems are not considered construction materials. Mechanical equipment is typically that which has motorized parts and/or is powered by a motor. Electrical equipment is typically any machine powered by electricity and includes components that are part of the electrical distribution system.

The following examples (including their appurtenances necessary for their intended use and operation) are NOT considered construction materials: pumps, motors, gear reducers, drives (including variable frequency drives (VFDs)), electric/pneumatic/manual accessories used to operate valves (such as electric valve actuators), mixers, gates, motorized screens (such as traveling screens), blowers/aeration equipment, compressors, meters, sensors, controls and switches, supervisory control and

data acquisition (SCADA), membrane bioreactor systems, membrane filtration systems, filters, clarifiers and clarifier mechanisms, rakes, grinders, disinfection systems, presses (including belt presses), conveyors, cranes, HVAC (excluding ductwork), water heaters, heat exchangers, generators, cabinetry and housings (such as electrical boxes/enclosures), lighting fixtures, electrical conduit, emergency life systems, metal office furniture, shelving, laboratory equipment, analytical instrumentation, and dewatering equipment.

23) If the iron or steel is produced in the US, may other steps in the manufacturing process take place outside of the US, such as assembly?

No. Production in the US of the iron or steel used in a listed product requires that all manufacturing processes must take place in the United States, except metallurgical processes involving refinement of steel additives.

24) What processes must occur in the US to be compliant with the AIS requirement for reinforced precast concrete?

While reinforced precast concrete may not be at least 50% iron or steel, in this particular case, the reinforcing bar and wire must be produced in the US and meet the same standards as for any other iron or steel product. Additionally, the casting of the concrete product must take place in the US. The cement and other raw materials used in concrete production are not required to be of domestic origin.

If the reinforced concrete is cast at the construction site, the reinforcing bar and wire are considered to be a construction material and must be produced in the US.

Compliance

25) How should an assistance recipient document compliance with the AIS requirement?

In order to ensure compliance with the AIS requirement, specific AIS contract language must be included in each contract, starting with the assistance agreement, all the way down to the purchase agreements. Sample language for assistance agreements and contracts can be found in Appendix 3 and 4.

EPA recommends the use of a step certification process, similar to one used by the Federal Highway Administration. The step certification process is a method to ensure that producers adhere to the AIS requirement and assistance recipients can verify that products comply with the AIS requirement. The process also establishes accountability and better enables States to take enforcement actions against violators.

Step certification creates a paper trail which documents the location of the manufacturing process involved with the production of steel and iron materials. A step certification is a process under which each handler (supplier, fabricator, manufacturer,

processor, etc) of the iron and steel products certifies that their step in the process was domestically performed. Each time a step in the manufacturing process takes place, the manufacturer delivers its work along with a certification of its origin. A certification can be quite simple. Typically, it includes the name of the manufacturer, the location of the manufacturing facility where the product or process took place (not its headquarters), a description of the product or item being delivered, and a signature by a manufacturer's responsible party. Attached, as Appendix 5, are sample certifications. These certifications should be collected and maintained by assistance recipients.

Alternatively, the final manufacturer that delivers the iron or steel product to the worksite, vendor, or contractor, may provide a certification asserting that all manufacturing processes occurred in the US. While this type of certification may be acceptable, it may not provide the same degree of assurance. Additional documentation may be needed if the certification is lacking important information. Step certification is the best practice.

26) How should a State ensure assistance recipients are complying with the AIS requirement?

In order to ensure compliance with the AIS requirement, States SRF programs must include specific AIS contract language in the assistance agreement. Sample language for assistance agreements can be found in Appendix 3.

States should also, as a best practice, conduct site visits of projects during construction and review documentation demonstrating proof of compliance which the assistance recipient has gathered.

27) What happens if a State or EPA finds a non-compliant iron and/or steel product permanently incorporated in the project?

If a potentially non-compliant product is identified, the State should notify the assistance recipient of the apparent unauthorized use of the non-domestic component, including a proposed corrective action, and should be given the opportunity to reply. If unauthorized use is confirmed, the State can take one or more of the following actions: request a waiver where appropriate; require the removal of the non-domestic item; or withhold payment for all or part of the project. Only EPA can issue waivers to authorize the use of a non-domestic item. EPA may use remedies available to it under the Clean Water Act, the Safe Drinking Water Act, and 40 CFR part 31 grant regulations, in the event of a violation of a grant term and condition.

It is recommended that the State work collaboratively with EPA to determine the appropriate corrective action, especially in cases where the State is the one who identifies the item in noncompliance or there is a disagreement with the assistance recipient.

If fraud, waste, abuse, or any violation of the law is suspected, the Office of Inspector General (OIG) should be contacted immediately. The OIG can be reached at 1-

888-546-8740 or OIG_Hotline@epa.gov. More information can be found at this website: http://www.epa.gov/oig/hotline.htm.

28) How do international trade agreements affect the implementation of the AIS requirements?

The AIS provision applies in a manner consistent with United States obligations under international agreements. Typically, these obligations only apply to direct procurement by the entities that are signatories to such agreements. In general, SRF assistance recipients are not signatories to such agreements, so these agreements have no impact on this AIS provision. In the few instances where such an agreement applies to a municipality, that municipality is under the obligation to determine its applicability and requirements and document the actions taken to comply for the State.

Waiver Process

The statute permits EPA to issue waivers for a case or category of cases where EPA finds (1) that applying these requirements would be inconsistent with the public interest; (2) iron and steel products are not produced in the US in sufficient and reasonably available quantities and of a satisfactory quality; or (3) inclusion of iron and steel products produced in the US will increase the cost of the overall project by more than 25 percent.

In order to implement the AIS requirements, EPA has developed an approach to allow for effective and efficient implementation of the waiver process to allow projects to proceed in a timely manner. The framework described below will allow States, on behalf of the assistance recipients, to apply for waivers of the AIS requirement directly to EPA Headquarters. Only waiver requests received from states will be considered. Pursuant to the Act, EPA has the responsibility to make findings as to the issuance of waivers to the AIS requirements.

Definitions

The following terms are critical to the interpretation and implementation of the AIS requirements and apply to the process described in this memorandum:

Reasonably Available Quantity: The quantity of iron or steel products is available or will be available at the time needed and place needed, and in the proper form or specification as specified in the project plans and design.

Satisfactory Quality: The quality of iron or steel products, as specified in the project plans and designs.

Assistance Recipient: A borrower or grantee that receives funding from a State CWSRF or DWSRF program.

Step-By-Step Waiver Process

Application by Assistance Recipient

Each local entity that receives SRF water infrastructure financial assistance is required by section 436 of the Act to use American made iron and steel products in the construction of its project. However, the recipient may request a waiver. Until a waiver is granted by EPA, the AIS requirement stands, except as noted above with respect to municipalities covered by international agreements.

The waiver process begins with the SRF assistance recipient. In order to fulfill the AIS requirement, the assistance recipient must in good faith design the project (where applicable) and solicit bids for construction with American made iron and steel products. It is essential that the assistance recipient include the AIS terms in any request for proposals or solicitations for bids, and in all contracts (see Appendix 3 for sample construction contract language). The assistance recipient may receive a waiver at any point before, during, or after the bid process, if one or more of three conditions is met:

1. Applying the American Iron and Steel requirements of the Act would be inconsistent with the public interest;
2. Iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or
3. Inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Proper and sufficient documentation must be provided by the assistance recipient. A checklist detailing the types of information required for a waiver to be processed is attached as Appendix 1.

Additionally, it is strongly encouraged that assistance recipients hold pre-bid conferences with potential bidders. A pre-bid conference can help to identify iron and steel products needed to complete the project as described in the plans and specifications that may not be available from domestic sources. It may also identify the need to seek a waiver prior to bid, and can help inform the recipient on compliance options.

In order to apply for a project waiver, the assistance recipient should email the request in the form of a Word document (.doc) to the State SRF program. It is strongly recommended that the State designate a single person for all AIS communications. The State SRF designee will review the application for the waiver and determine whether the necessary information has been included. Once the waiver application is complete, the State designee will forward the application to either of two email addresses. For CWSRF waiver requests, please send the application to: cwsrfwaiver@epa.gov. For DWSRF waiver requests, please send the application to: dwsrfwaiver@epa.gov.

Evaluation by EPA

After receiving an application for waiver of the AIS requirements, EPA Headquarters will publish the request on its website for 15 days and receive informal comment. EPA Headquarters will then use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to determine whether or not to grant the waiver.

In the event that EPA finds that adequate documentation and justification has been submitted, the Administrator may grant a waiver to the assistance recipient. EPA will notify the State designee that a waiver request has been approved or denied as soon as such a decision has been made. Granting such a waiver is a three-step process:

1. Posting – After receiving an application for a waiver, EPA is required to publish the application and all material submitted with the application on EPA's website for 15 days. During that period, the public will have the opportunity to review the request and provide informal comment to EPA. The website can be found at: http://water.epa.gov/grants_funding/aisrequirement.cfm

2. Evaluation – After receiving an application for waiver of the AIS requirements, EPA Headquarters will use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to determine whether or not to grant the waiver.

3. Signature of waiver approval by the Administrator or another agency official with delegated authority – As soon as the waiver is signed and dated, EPA will notify the State SRF program, and post the signed waiver on our website. The assistance recipient should keep a copy of the signed waiver in its project files.

Public Interest Waivers

EPA has the authority to issue public interest waivers. Evaluation of a public interest waiver request may be more complicated than that of other waiver requests so they may take more time than other waiver requests for a decision to be made. An example of a public interest waiver that might be issued could be for a community that has standardized on a particular type or manufacturer of a valve because of its performance to meet their specifications. Switching to an alternative valve may require staff to be trained on the new equipment and additional spare parts would need to be purchased and stocked, existing valves may need to be unnecessarily replaced, and portions of the system may need to be redesigned. Therefore, requiring the community to install an alternative valve would be inconsistent with public interest.

EPA also has the authority to issue a public interest waiver that covers categories of products that might apply to all projects.

EPA reserves the right to issue national waivers that may apply to particular classes of assistance recipients, particular classes of projects, or particular categories of iron or steel products. EPA may develop national or (US geographic) regional categorical waivers through the identification of similar circumstances in the detailed justifications presented to EPA in a waiver request or requests. EPA may issue a national waiver based on policy decisions regarding the public's interest or a determination that a particular item is not produced domestically in reasonably available quantities or of a sufficient quality. In such cases, EPA may determine it is necessary to issue a national waiver.

If you have any questions concerning the contents of this memorandum, you may contact us, or have your staff contact Jordan Dorfman, Attorney-Advisor, State Revolving Fund Branch, Municipal Support Division, at dorfman.jordan@epa.gov or (202) 564-0614 or Kiri Anderer, Environmental Engineer, Infrastructure Branch, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134.

Attachments

Appendix 1: Information Checklist for Waiver Request

The purpose of this checklist is to help ensure that all appropriate and necessary information is submitted to EPA. EPA recommends that States review this checklist carefully and provide all appropriate information to EPA. This checklist is for informational purposes only and does not need to be included as part of a waiver application.

Items	✓	Notes
General • Waiver request includes the following information: — Description of the foreign and domestic construction materials — Unit of measure — Quantity — Price — Time of delivery or availability — Location of the construction project — Name and address of the proposed supplier — A detailed justification for the use of foreign construction materials • Waiver request was submitted according to the instructions in the memorandum • Assistance recipient made a good faith effort to solicit bids for domestic iron and steel products, as demonstrated by language in requests for proposals, contracts, and communications with the prime contractor		
Cost Waiver Requests • Waiver request includes the following information: — Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products — Relevant excerpts from the bid documents used by the contractors to complete the comparison — Supporting documentation indicating that the contractor made a reasonable survey of the market, such as a description of the process for identifying suppliers and a list of contacted suppliers		
Availability Waiver Requests • Waiver request includes the following supporting documentation necessary to demonstrate the availability, quantity, and/or quality of the materials for which the waiver is requested: — Supplier information or pricing information from a reasonable number of domestic suppliers indicating availability/delivery date for construction materials — Documentation of the assistance recipient's efforts to find available domestic sources, such as a description of the process for identifying suppliers and a list of contacted suppliers. — Project schedule — Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of construction materials • Waiver request includes a statement from the prime contractor and/or supplier confirming the non-availability of the domestic construction materials for which the waiver is sought • Has the State received other waiver requests for the materials described in this waiver request, for comparable projects?		

Appendix 2: HQ Review Checklist for Waiver Request

Instructions: To be completed by EPA. Review all waiver requests using the questions in the checklist, and mark the appropriate box as Yes, No or N/A. Marks that fall inside the shaded boxes may be grounds for denying the waiver. If none of your review markings fall into a shaded box, the waiver is eligible for approval if it indicates that one or more of the following conditions applies to the domestic product for which the waiver is sought:

1. The iron and/or steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality.
2. The inclusion of iron and/or steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Review Items	Yes	No	N/A	Comments
Cost Waiver Requests • Does the waiver request include the following information? — Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products — Relevant excerpts from the bid documents used by the contractors to complete the comparison — A sufficient number of bid documents or pricing information from domestic sources to constitute a reasonable survey of the market • Does the Total Domestic Project exceed the Total Foreign Project Cost by more than 25%?				
Availability Waiver Requests • Does the waiver request include supporting documentation sufficient to show the availability, quantity, and/or quality of the iron and/or steel product for which the waiver is requested? — Supplier information or other documentation indicating availability/delivery date for materials — Project schedule — Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of materials • Does supporting documentation provide sufficient evidence that the contractors made a reasonable effort to locate domestic suppliers of materials, such as a description of the process for identifying suppliers and a list of contacted suppliers? • Based on the materials delivery/availability date indicated in the supporting documentation, will the materials be unavailable when they are needed according to the project schedule? (By item, list schedule date and domestic delivery quote date or other relevant information) • Is EPA aware of any other evidence indicating the non-availability of the materials for which the waiver is requested? Examples include: — Multiple waiver requests for the materials described in this waiver request, for comparable projects in the same State — Multiple waiver requests for the materials described in this waiver request, for comparable projects in other States — Correspondence with construction trade associations indicating the non-availability of the materials • Are the available domestic materials indicated in the bid documents of inadequate quality compared those required by the project plans, specifications, and/or permits?				

Appendix 3: Example Loan Agreement Language

ALL ASSISTANCE AGREEMENT MUST HAVE A CLAUSE REQUIRING COMPLIANCE WITH THE AIS REQUIREMENT. THIS IS AN EXAMPLE OF WHAT COULD BE INCLUDED IN SRF ASSISTANCE AGREEMENTS. EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THIS CLAUSE WITH RESPECT TO STATE LAW:

Comply with all federal requirements applicable to the Loan (including those imposed by the 2014 Appropriations Act and related SRF Policy Guidelines) which the Participant understands includes, among other, requirements that all of the iron and steel products used in the Project are to be produced in the United States ("American Iron and Steel Requirement") unless (i) the Participant has requested and obtained a waiver from the Agency pertaining to the Project or (ii) the Finance Authority has otherwise advised the Participant in writing that the American Iron and Steel Requirement is not applicable to the Project.

Comply with all record keeping and reporting requirements under the Clean Water Act/Safe Drinking Water Act, including any reports required by a Federal agency or the Finance Authority such as performance indicators of program deliverables, information on costs and project progress. The Participant understands that (i) each contract and subcontract related to the Project is subject to audit by appropriate federal and state entities and (ii) failure to comply with the Clean Water Act/Safe Drinking Water Act and this Agreement may be a default hereunder that results in a repayment of the Loan in advance of the maturity of the Bonds and/or other remedial actions.

Appendix 4: Sample Construction Contract Language

ALL CONTRACTS MUST HAVE A CLAUSE REQUIRING COMPLIANCE WITH THE AIS REQUIREMENT. THIS IS AN EXAMPLE OF WHAT COULD BE INCLUDED IN ALL CONTRACTS IN PROJECTS THAT USE SRF FUNDS. EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THIS CLAUSE WITH RESPECT TO STATE OR LOCAL LAW:

The Contractor acknowledges to and for the benefit of the City of _ ("Purchaser") and the _ (the "State") that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as "American Iron and Steel;" that requires all of the iron and steel products used in the project to be produced in the United States ("American Iron and Steel Requirement") including iron and steel products provided by the Contactor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney's fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

Appendix 5: Sample Certifications

The following information is provided as a sample letter of **step** certification for AIS compliance. Documentation must be provided on company letterhead.

Date

Company Name

Company Address

City, State Zip

Subject: American Iron and Steel Step Certification for Project (XXXXXXXXXX)

I, (company representative), certify that the (melting, bending, coating, galvanizing, cutting, etc.) process for (manufacturing or fabricating) the following products and/or materials shipped or provided for the subject project is in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. Xxxx
2. Xxxx
3. Xxxx

Such process took place at the following location:

_____

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

The following information is provided as a sample letter of certification for AIS compliance. Documentation must be provided on company letterhead.

Date

Company Name

Company Address

City, State Zip

Subject: American Iron and Steel Certification for Project (XXXXXXXXXX)

I, (company representative), certify that the following products and/or materials shipped/provided to the subject project are in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. Xxxx
2. Xxxx
3. Xxxx

Such process took place at the following location:

_____

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

American Iron & Steel (AIS) Requirement of the Consolidated Appropriations Act of 2014
(Public Law 113-76)

Q&A Part 2

PRODUCT QUESTIONS

1. **Q: Do all fasteners qualify for de minimis exemption?**

   A: No. There is no broad exemption for fasteners from the American Iron and Steel (AIS) requirements. Significant fasteners used in SRF projects are not subject to the de minimis waiver for projects and must comply with the AIS requirements. Significant fasteners include fasteners produced to industry standards (e.g., ASTM standards) and/or project specifications, special ordered or those of high value. When bulk purchase of unknown-origin fasteners that are of incidental use and small value are used on a project, they may fall under the national de minimis waiver for projects. The list of potential items could be varied, such as big-box/hardware-store-variety screws, nails, and staples. The key characteristics of the items that may qualify for the de minimis waiver would be items that are incidental to the project purpose (such as drywall screws) and not significant in value or purpose (such as common nails or brads). See the following: http://water.epa.gov/grants_funding/upload/Deminimis-Waiver-04-15-14.pdf.

   EPA also clarifies that minor components of two listed products – valves and hydrants -- may not need to meet the AIS requirements if the minor components compromise a very small quantity of minor, low-cost fasteners that are of unknown origin. See EPA's questions and answers on the subject at the following: http://water.epa.gov/grants_funding/upload/AIS-QandA-Part-1-Valves-and-Hydrants-final.pdf.

2. **Q: Does PCCP pipe have to be domestically produced?**

   A: Yes. Pre-stressed concrete cylinder pipe (PCCP) or other similar concrete cylinder pipes would be comparable to pre-cast concrete which is specifically listed in the Consolidated Appropriations Act of 2014 as a product subject to the AIS requirement.

3. **Q: If the iron or steel is made from recycled metals will the vendor/supplier have to provide a certification document certifying that the recycled metals are domestically produced?**

   A: No. Recycled source materials used in the production of iron and steel products do not have to come from the U.S. Iron or steel scrap, for instance, are considered raw materials that may come from anywhere. While certification is not required for the raw material, EPA does recommend that additional final processing of iron and steel be certified to have occurred in the U.S.

4. **Q: Do tanks used for filtration systems, if delivered to the construction site separately and then filled with filtration media onsite, have to be domestically produced?**

A: No. Tanks that are specifically designed to be filters, or as parts of a filtration system, do not have to be domestically produced because these parts are no longer simply tanks, even if the filter media has not been installed and will be installed at the project site, as is customary to do for shipping purposes. These parts have only one purpose which is to be housing for filters and cannot be used in another fashion.

5. **Q: Can a recipient use non-domestic flanged pipe?**

   A: No. While the Consolidated Appropriations Act of 2014 does not specifically mention flanged pipe, since it does mention both pipe and flanges, both products would need to be domestically produced. Therefore, flanged pipe would also need to be domestically produced.

6. **Q: Can a recipient use non-domestic couplings, expansion joints, and other similar pipe connectors?**

   A: No. These products would be considered specialty fittings, due to their additional functionality, but still categorized under the larger "fitting" categorization. Fittings are defined as a material that joins pipes together or connects to a pipe (AWWA, The Drinking Water Dictionary, 2000). Therefore, these products must comply with the AIS requirements and be produced domestically.

7. **Q: Can a recipient use non-domestic service saddles and tapping sleeves?**

   A: No. These products are necessary for pipe repair, to tap a water main, or to install a service or house connection. Therefore, they are included under the larger "pipe restraint" category which is a specifically identified product subject to the domestic preference in the Consolidated Appropriations Act of 2014.

8. **Q: The AIS guidance does not appear to cover reused items (i.e., existing pipe fittings, used storage tanks, reusing existing valves). How should reused items be addressed?**

   A: The AIS guidance does not address reuse of items. Reuse of items that would otherwise be covered by AIS is acceptable provided that the item(s) was originally purchased prior to January 17, 2014, the reused item(s) is not substantially altered from original form/function, and any restoration work that may be required does not include the replacement or addition of foreign iron or steel replacement parts. EPA recommends keeping a log of these reused items by including them on the assistance recipient's de minimis list, and stating therein that these items are reused products. The donation of new items (such as a manufacturer waiving cost for certain delivered items because of concerns regarding the origin of a new product) is not, however, considered reuse.

9. **Q: What does "time needed" mean in the AIS guidance, in reference to the definition of "Reasonably Available Quantity"?**

A: For considering whether a product would meet reasonably available quantity, "time needed" is based on the construction schedule. If the item is delayed and there is substantial impact on the overall construction schedule, this would not be according to the "time needed."

10. **Q: If a product is not specifically included on the list of AIS covered products, must it comply with AIS?**

    A: Possibly. The AIS requirements include a list of specifically covered products, one of which is construction materials, a broad category of potential products. For construction materials, EPA's AIS guidance includes a set of example items that it considers construction materials composed primarily of iron and steel and covered by the Act. This example list in the guidance is not an all-inclusive list of potential construction materials. However, the guidance also includes a list of items that EPA specifically does not consider construction materials, generally those of electrical or complex-mechanical nature. If a product is similar to the ones in the non-construction material list (and it is also not specifically listed by the Act), it is not a construction material. For all other items specifically included in the Act, coverage is generally self-evident.

11. **Q: If a listed iron and steel product is used as a part for an assembled product that is non-domestic, do the AIS requirements apply?**

    A: AIS requirements only apply to the final product as delivered to the work site and incorporated into the project. Other assemblies, such as a pumping assembly or a reverse osmosis package plant, are distinct products not listed and do not need to be made in the U.S. or composed of all U.S. parts. Therefore, for the case of a non-covered product used in a larger non-domestic assembly, the components, even if specifically listed in the Consolidated Appropriations Act, do not have to be domestically produced.

12. **Q: Is cast iron excluded from the AIS requirements?**

    A: No. Cast iron products that fall under the definition of iron and steel products must comply with the AIS requirements.

13. **Q: The guidance states that "construction materials" do not include mechanical equipment, but then identifies ductwork as a construction material. Please clarify.**

    A: Ductwork is not mechanical equipment, therefore it is considered a "construction material" and must comply with the AIS requirements.

14. **Q: Do "meters" mentioned in EPA's guidance as non-construction materials include both flow meters and water meters?**

    A: Yes. "Meters" includes any type of meter, including: flow meters, wholesale meters, and water meters/service connections.

15. **Q: Must coiled steel be domestic?**

    A: Yes. Coiled steel is an intermediate product used in the production of steel pipe and must come from a U.S. source or subject to a waiver in order to comply with the AIS requirements.

16. **Q: Are pig iron, direct reduced iron (DRI), and ingot considered raw materials?**

    A: No. These are considered intermediate products used in the production of iron or steel and must come from a U.S. source or subject to a waiver in order to comply with the AIS requirements.

17. **Q: Can assistance recipients rely on a marking that reads, "Made in the USA," as evidence that all processes took place in the U.S.?**

    A: No. This designation is not consistent with our requirements that all manufacturing processes of iron and steel products must take place in the U.S.

18. **Q: When determining what constitutes a product made "primarily" of iron or steel, who makes this determination?**

    A: The manufacturer will show if its product qualifies as primarily made of iron or steel. The recipient should expect the manufacturer to provide documentation/ certification that its product is AIS compliant.

19. **Q: Do aerators need to be produced domestically in order to comply with AIS?**

    A: No. Aerators, similar to pumps, are mechanical equipment that do not need to meet the AIS requirements. "Blowers/aeration equipment, compressors" are listed in EPA's guidance as non-construction materials.

20. **Q: Are Sluice and Slide Gates considered valves?**

    A: No. Valves are products that are generally encased / enclosed with a body, bonnet, and stem. Examples include enclosed butterfly, ball, globe, piston, check, wedge, and gate valves. Furthermore, "gates" (meaning sluice, slide or weir gates) are listed in EPA's guidance as non-construction materials.

AIS PROCESS QUESTIONS

21. **Q: Will notices of waiver applications be published in the federal register?**

    A: No. Applications for waivers will be published on EPA's website (http://water.epa.gov/grants_funding/aisrequirement.cfm**).** EPA will provide 15 days for open public comment, as noted on the website.

22. **Q: Will states be collecting the step certification paper trail, as presented in the AIS guidance?**

    A. No. Assistance recipients must maintain documentation of compliance with AIS. EPA recommends use of the step certification process. This process is a best practice and traces all manufacturing of iron and steel products to the U.S. If the process is used, the state does not have to collect the documentation. The documents must be kept by the assistance recipient and reviewed by the state during project reviews.

23. **Q: Why is it considered a best practice for states to conduct site visits, when it is the assistance recipient's responsibility to meet the AIS requirements?**

    A: It is both the assistance recipient's and the state's responsibility to ensure compliance with the AIS requirements. The state is the recipient of a federal grant and must comply with all grant conditions, including a condition requiring that the AIS requirements be adhered to. Therefore, it is recommended that states conduct site visits of projects during construction and review documentation demonstrating the assistance recipient's proof of compliance.

24. **Q: Please further define the state's role in the waiver process.**

    A: The state's role in the waiver process is to review any waiver requests submitted to the state in order to ensure that all necessary information has been provided by the assistance recipient prior to forwarding the request to EPA. If a state finds the request lacking, the state should work with the assistance recipient to help obtain complete information.

25. **Q: How much time does EPA have to evaluate the waiver during the evaluation step?**

    A: At a minimum, EPA is required to provide 15 days for open public comment. There is no specific deadline or time limit for EPA to review waiver requests. Each waiver request will come with its own specific details and circumstances and may require a different amount of time for review and analysis. For example, public interest waivers in general may take longer to review than availability waivers which are typically more straightforward. However, EPA understands that construction may be delayed while waiting for a waiver and will make every effort to review and issue decisions on waiver requests in a timely manner.

<u>PROJECT QUESTIONS</u>

26. **Q: What if a project is funded by another funding entity (i.e., United States Department of Agriculture – Rural Development) where AIS is not required and begins construction after January 17, 2014 but then applies to the SRF to refinance the project? Are they ineligible?**

A: The project is not ineligible. AIS requirements will apply to any construction that occurs after the assistance agreement is signed, through the end of construction. If construction is complete, there is no retroactive application of the AIS requirements.

27. **Q: If the assistance recipient can demonstrate through market research that the AIS requirement will exceed the 25 percent cost threshold, is the entire project exempt from the AIS requirement?**

    A: If the waiver application shows that the inclusion of American iron and steel products causes the entire cost of the project to increase by more the 25 percent, a waiver may be granted for the entirety of the project.

28. **Q: Can the recipient use non-SRF funds to pay for the non-compliant item.**

    A: No. It is not an acceptable to use non-SRF funds to pay for a non-compliant item. The Consolidated Appropriations Act of 2014 requires that all iron and steel products, no matter the source of funding, must be made in the U.S. if SRF funds are used in the project.

29. **Q: What constitutes "satisfactory quality" as defined in the AIS guidance, in reference to the availability waiver process.**

    A: "Satisfactory quality" means the product meets the project design specifications. A waiver may be granted if a recipient determines that the project plans and design would be compromised because there are no American made products available that meet the project design specifications.

30. **Q: The guidance states that the AIS requirement applies to any project "funded in whole or in part" by an SRF. Where is this in the Act?**

    A: The Act states that, "None of the funds made available by a … [State SRF program] … shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States." This sentence clearly states that no SRF program may use its funds for a project unless all of the iron and steel products used in the project are made in the U.S. This is true even if only $1 of SRF funding is used in the project.

31. **Q: There is always an expectation on the part of an assistance recipient that the construction phase of a planning and/or design only loan will be funded through the SRF. If the original planning and/or design only loan was executed prior to a January 17, 2014, does this mean the entire project will be exempt from the AIS requirement?**

    A: If the original loan includes construction, and was executed prior to January 17, 2014, then the AIS provision does not apply to the project. If the original loan was only for planning and/or design, then a written commitment or documented "expectation" is needed to show exemption from the

requirements. Appearance on a priority list in an Intended Use Plan along with written reasonable assurance from the state that the recipient will receive SRF funding for project construction could provide sufficient evidence of "expectation of funding".

32. **Q: What if there has been a change order or redesign requiring new plans and specifications to be approved and they were approved after January 17, 2014: does the project now have to comply with AIS?**

    A: In most cases, no. Change orders are typically small enough changes that the original plan and specification date will still hold true. For example, if a pipe alignment has to be changed for a block or two due to unforeseen conditions, but new plans and specifications had to be submitted for this section of the project, then that could be considered a minor change. However, if there has been a major redesign, perhaps the whole project had to be redesigned starting from scratch, then the new plans and specification approval date would apply.

33. **Q: What if the bids on a project with plans and specifications approved before January 17, 2014 but the loan is signed after January 17, 2014 come in low, and there is significant funding remaining in the loan agreement, so the community designs a second project with the remaining funds: does that project have to comply with the AIS requirements?**

    A: If the second project is closely related in purpose, place and time to the first project, then the second project would be exempt from the AIS requirements. It is the assistance recipient's responsibility (with state oversight) to show that a project is closely related, or not, in purpose, place and time.

34. **Q: What if the assistance agreement was signed after January 17, 2014, state approval of plans for the first phase of the project was in place prior to January 17, 2014, but state approval of the plans for the second phase of the project was received after January 17, 2014?**

    A: In such a case, the AIS provision would not apply to the first phase of the project. If the second phase of the project is considered the same project as the first phase, due to its close relation in purpose, place and time, the entire project may be exempt. It is the assistance recipient's responsibility (with state oversight) to show that phases of a project is closely related, or not, in purpose, place and time.

35. **Q: Do products purchased through procurement-only contracts have to be comply with AIS?**

    A: Yes. For projects funded by SRF, the products procured under any form of contract must comply with AIS. A procurement-only contract generally involves the bulk purchase of common items (such as pipe, concrete, and/or pumps) of independent timing from a set of planned projects. If products which are purchased through a procurement-only contract are being installed under another contract, the procurement-only contract would probably not be considered a separate project in purpose, place and time; and therefore, would have to comply with the AIS requirements.

March 2015

American Iron & Steel Requirement for the Clean Water and Drinking Water State Revolving Funds

Q&A Part 3

*For CWSRF and DWSRF: On **January 17, 2014**, Public Law 113-76, the "Consolidated Appropriations Act, 2014," was enacted and included an American Iron and Steel requirement for the Clean Water and Drinking Water State Revolving Fund programs through the end of fiscal year 2014. Since then, the AIS requirement has continued for both programs, but through different statutes, with a few changes as described in the questions and answers provided below.*

*For CWSRF: On **June 10, 2014**, the Water Resources Reform and Development Act amended the Clean Water Act to include permanent requirements for the use of AIS products in CWSRF assistance agreements. Section 608 of the CWA now contains requirements for AIS that repeat those of the Consolidated Appropriations Act, 2014. All CWSRF assistance agreements must comply with Section 608 of the CWA for implementation of the permanent AIS requirement.*

*For DWSRF: On **December 16, 2014**, the President signed Public Law 113- 235, the "Consolidated and Further Continuing Appropriations Act, 2015," which provides fiscal year 2015 full-year appropriations through September 30, 2015. This law continues the requirement for the use of AIS products in DWSRF assistance agreements through September 30, 2015.*

CWSRF PROGRAM

1. **Q: The Water Resources Reform and Development Act amended the Clean Water Act to include permanent requirements for the use of AIS for CWSRF funded assistance agreements. Does the CWA include an exemption for plans and specifications approved prior to the enactment of the legislation similar to the exemption included in the Consolidated Appropriations Act (CAA) 2014?**

   A: Yes. The WRRDA amendment to the CWA, which included AIS requirements, included a similar exemption as the CAA 2014. For any CWSRF assistance agreement signed on or after October 1, 2014, if the plans and specifications were approved prior to June 10, 2014 (the enactment of WRRDA), then the project is exempt from AIS requirements. For assistance agreements signed prior to October 1, 2014, the previous dates in the CAA 2014 apply (see March 20, 2014, AIS guidance document).

   If a project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the plans and specifications approval date for purposes of this exemption in Section 608 (f).

   The following table summarizes AIS exemptions based on the plans and specifications approval date for CWSRF funded projects.

CWSRF AIS Project Exemption Based on Plans and Specifications Approval Date		
Assistance Agreement Signed:	Exempt from AIS if Plans and Specifications Were Approved Before:	Basis for Exemption:
1/17/2014 through 9/30/2014	4/15/2014	• Consolidated Appropriations Act 2014 • National waiver signed 4/15/2014*
On or after 10/1/2014	6/10/2014	• Clean Water Act Section 608

** To be covered by the national waiver, the plans and specifications had to be submitted to the state prior to 1/17/2014*

2. **Q: Does the AIS requirement apply to refinanced CWSRF projects?**

   A: Yes, in some cases. If a project began construction, financed from a non-CWSRF source prior to June 10, 2014, but is refinanced through a CWSRF assistance agreement executed on or after October 1, 2014, AIS requirements will apply to all construction that occurs on or after June 10, 2014, through completion of construction, unless engineering plans and specifications were approved by the responsible state agency prior to June 10, 2014. For CWSRF projects funded on or after October 1, 2014, there is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to June 10, 2014.

DWSRF PROGRAM

3. **Q: The Consolidated and Further Continuing Appropriations Act 2015 continues the AIS requirements for DWSRF funded assistance agreements. Does the Act include an exemption for plans and specifications approved prior to the enactment of the legislation, similar to the exemption included in the Consolidated Appropriations Act (CAA) 2014?**

   A: Yes. The Consolidated and Further Continuing Appropriations Act 2015 includes a similar exemption as the CAA 2014. For any assistance agreement signed on or after December 16, 2014 (the enactment of the Act), if the plans and specifications were approved prior to December 16, 2014, then the project is exempt from the AIS requirements. For assistance agreements signed prior to December 16, 2014, the previous dates in the CAA 2014 apply (see March 20, 2014 AIS guidance document).

   If a project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the plans and specifications approval date for purposes of the exemption in Section 424(f).

4. **Q: Do DWSRF assistance agreements signed during the time period between September 30, 2014, and December 16, 2014, still have to comply with the AIS requirements?**

A: Yes. The Continuing Appropriations Resolution 2015 was signed on September 19, 2014, which extended funding for the DWSRF with the same conditions that were made applicable by the language in the Fiscal Year 2014 appropriations, including the requirement for the use of American Iron and Steel products in projects receiving financial assistance from the DWSRF. Therefore, all assistance agreements starting October 1, 2014, through the enactment of the Consolidated and Further Continuing Appropriations Act 2015 (signed December 16, 2014), must include the AIS requirements. However, if the plans and specifications for any of these projects were approved prior to April 15, 2014 (the date the national waiver was signed), then the project is exempt from the AIS requirements.

The following table summarizes AIS exemptions based on the plans and specifications approval date for DWSRF funded projects.

DWSRF AIS Project Exemption Based on Plans and Specifications Approval Date		
Assistance Agreement Signed:	Exempt from AIS if Plans and Specifications Were Approved Before:	Basis for Exemption:
1/17/2014 through 9/30/2014	4/15/2014	• Consolidated Appropriations Act 2014 • National waiver signed 4/15/2014*
10/1/2014 through 12/15/2014	4/15/2014	• Continuing Appropriations Resolution 2015 (continued CAA 2014 requirements)** • National waiver signed 4/15/2014*
12/16/2014 through 9/30/2015	12/16/2014	• Consolidated and Further Continuing Appropriations Act 2015

** To be covered by the national waiver, the plans and specifications had to be submitted to the state prior to 1/17/2014*

*** Following the first continuing resolution, there were two additional CRs to fill the gap between 12/11/2014 and 12/16/2014*

5. **Q: Does the AIS requirement apply to refinanced DWSRF projects?**

A: Yes, in some cases. If a project began construction, financed from a non-DWSRF source prior to December 16, 2014, but is refinanced through a DWSRF assistance agreement executed on or after December 16, 2014, AIS requirements will apply to all construction that occurs on or after December 16, 2014, through completion of construction, unless engineering plans and

specifications were approved by the responsible state agency prior to December 16, 2014. For DWSRF projects funded on or after December 16, 2014, there is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to December 16, 2014.

BOTH CWSRF AND DWSRF PROGRAMS

6. **Q: If a coating is applied to the external surface of a domestic iron or steel component, and the application takes place outside of the United States, would the product be compliant under the AIS requirements?**

   A: Yes. The product would still be considered a compliant product under AIS requirements. Any coating processes that are applied to the external surface of iron and steel components that would otherwise be AIS compliant would not disqualify the product from meeting the AIS requirements regardless of where the coating processes occur, provided that final assembly of the product occurs in the United States.

   The exemption above only applies to coatings on the *external surface* of iron and steel components. It does not apply to coatings or linings on internal surfaces of iron and steel products, such as the lining of lined pipes. All manufacturing processes for lined pipes, including the application of pipe lining, must occur in the United States for the product to be compliant with AIS requirements.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

DECISION MEMORANDUM

SUBJECT: De Minimis Waiver of Section 436 of P.L. 113-76, Consolidated Appropriations Act (CAA), 2014

FROM: Nancy K. Stoner
Acting Assistant Administrator

The EPA is hereby granting a nationwide waiver pursuant to the "American Iron and Steel (AIS)" requirements of P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), section 436 under the authority of Section 436(b)(**1)** (public interest waiver) for de minimis incidental components of eligible water infrastructure projects. This action permits the use of products when they occur in de minimis incidental components of such projects funded by the Act that may otherwise be prohibited under section 436(a). Funds used for such de minimis incidental components cumulatively may comprise no more than a total of 5 percent of the total cost of the materials used in and incorporated into a project; the cost of an individual item may not exceed **1** percent of the total cost of the materials used in and incorporated into a project.

P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), includes an "American Iron and Steel" (AIS) requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use specific domestic iron and steel products that are produced in the United States if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Fiscal Year 2014, unless the agency determines it necessary to waive this requirement based on findings set forth in Section 436(b). The Act states, "[the requirements] shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency ...finds that- (1) applying subsection (a) would be inconsistent with the public interest" 436(b**)(1**).

In implementing section 436 of the Act, the EPA must ensure that the section's requirements are applied consistent with congressional intent in adopting this section and in the broader context of the purposes, objectives, and other provisions applicable to projects funded under the SRF. Water infrastructure projects typically contain a relatively small number of high-cost components incorporated into the project. In bid solicitations for a project, these high-cost components are generally described in detail via project specific technical specifications. For these major components, utility owners and their contractors are generally familiar with the conditions of availability, the potential alternatives for each detailed specification, the approximate cost, and the country of manufacture of the available components.

Every water infrastructure project also involves the use of thousands of miscellaneous, generally low-cost components that are essential for, but incidental to, the construction and are incorporated into the physical structure of the project. For many of these incidental components, the country of manufacture and the availability of alternatives is not always readily or reasonably identifiable prior to procurement in the normal course of business; for other incidental components, the country of manufacture may be known but the miscellaneous character in conjunction with the low cost, individually and (in total) as typically procured in bulk, mark them as properly incidental. Examples of incidental components could include small washers, screws, fasteners (i.e., nuts and bolts), miscellaneous wire, comer bead, ancillary tube, etc. Examples of items that are clearly not incidental include significant process fittings (i.e., tees, elbows, flanges, and brackets), distribution system fittings and valves, force main valves, pipes for sewer collection and/or water distribution, treatment and storage tanks, large structural support structures, etc.

The EPA undertook multiple inquiries to identify the approximate scope of de minimis incidental components within water infrastructure projects during the implementation of the American Reinvestment and Recovery Act (ARRA) and its requirements (Buy American provisions, specifically). The inquiries and research conducted in 2009 applies suitably for the case today. In 2009, the EPA consulted informally with many major associations representing equipment manufacturers and suppliers, construction contractors, consulting engineers, and water and wastewater utilities, and performed targeted interviews with several well-established water infrastructure contractors and firms who work in a variety of project sizes, and regional and demographic settings to ask the following questions:

- What percentage of total project costs were consumables or incidental costs?

- What percentage of materials costs were consumables or incidental costs?

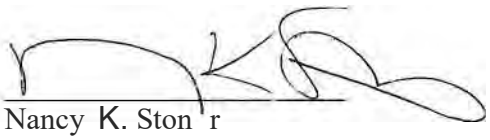
- Did these percentages vary by type of project (drinking water vs. wastewater treatment plant vs. pipe)?

The responses were consistent across the variety of settings and project types, and indicated that the percentage of total costs for drinking water or wastewater infrastructure projects represented by these incidental components is generally not in excess of 5 percent of the total cost of the materials used in and incorporated into a project. In drafting this waiver, the EPA has considered the de minimis proportion of project costs generally represented by each individual type of these incidental components within the many types of such components comprising those percentages, the fact that these types of incidental components are obtained by contractors in many different ways from many different sources, and the disproportionate cost and delay that would be imposed on projects if the EPA did not issue this waiver.

Assistance recipients who wish to use this waiver should in consultation with their contractors determine the items to be covered by this waiver and must retain relevant documentation (i.e., invoices) as to those items in their project files.

If you have any questions concerning the contents of this memorandum, please contact Timothy Connor, Chemical Engineer, Municipal Support Division, at connor.timothy@epa.gov or (202) 566-1059 or Kirsten Anderer, Environmental Engineer, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134.

Issued on: APR 15 2014

Approved by: 

Nancy K. Stoner
Acting Assistant Administrator

Ohio Water Pollution Control Loan Fund
Use of American Iron and Steel - De Minimis Final Utilization and Certification Form

The Consolidated Appropriations Act of 2014 (P.L. 113-76) Section 436 requires the use of American & Steel in SRF-funded projects. Under the authority of Section 436(b)(1), the EPA has issued a public interest waiver for De Minimis incidental components. The assistance recipient wishing to use this waiver should consult with their contractor(s) to maintain an itemized list of components covered under De Minimis. At the conclusion of the project, this form must be completed and retained in the assistance recipient's project files and a copy provided to DEFA. Please print clearly or type.

Project Name:_____ Loan Agrmt #: _____

NOTE: The De Minimis waiver is only applicable to the cost of materials for the entire project. Do not include other project costs (labor, installation costs, etc.) in the "Total Cost of Materials". The cost of a material must include delivery to the site and any applicable tax. Must have sufficient documentation to support all costs included in this calculation.

Funds used for de minimis incidental components cumulatively may comprise no more than a total of 5 percent of the total cost of the materials used in and incorporated into a project; the cost of an individual item may not exceed 1 percent of the total cost of the materials used in and incorporated into a project.

Total Cost of Materials: _____ 5% Limit: _____ 1% limit: _____

Manufacturer & Component Description	Part/Model #	Quantity (if applicable)	Cost per Unit (if applicable)	Component's Total Cost	How is Cost Documented?*

Use additional sheets as necessary

Total De Minimis Cost of Components: _____

If approaching the 5% or 1% limits, contact DEFA immediately

* Documentation must demonstrate confirmation of the components' actual costs (invoice, etc.).

Completed by:

Name: _____ Title: _____

Signature: _____ Date: _____

Violating Facilities Clause

(Required Contract Provision)

Language prohibiting this use of equipment or services from anyone on the EPA List of Violating Facilities must be included in the contract documents.

Violating Facilities:

The Contractor agrees to comply with all applicable standards, orders or requirements under Section 306 of the Clean Air Act, 42 USC 1857 (h), Section 508 of the Clean Water Act, 33 USC 1368, Executive Order 11738, and EPA regulations, 40 CFR Part 32, which prohibits the use under non-exempt Federal contracts, grants, or loans of facilities included on the EPA List of Violating Facilities.

Requirement For Utilization Of Small Businesses In Rural Areas (SBRA)

(Required Contract Provision)

The following policy should be added to the "Instructions to Bidders" section and referenced in the Table of Contents for the contract documents:

> This procurement is subject to the EPA policy of encouraging the participation of small businesses in rural areas. It is EPA policy that recipients of EPA financial assistance awards utilize the services of small businesses in rural areas (SBRAs), to the maximum extent practicable. The objective is to assure that such small business entities are afforded the maximum practicable opportunity to participate as subcontractors, suppliers and otherwise in EPA-awarded financial assistance programs. This policy applies to all contracts and subcontracts for supplies, construction, and services under EPA grants or cooperative agreements. Small purchases are also subject to this policy.

If possible, also add the following language to the "Advertisement for Bids":

> This procurement is subject to the EPA policy of encouraging the participation of small business in rural areas (SBRAs).

Insurance Provisions

(Required Contract Provision)

Section 3.5 of the WPCLF/WSRLA Loan Agreement contains specific requirements regarding insurance for all contractors and all subcontractors for the life of the contract. These insurance requirements must be reflected in the contract documents. Adjust the following language as needed to meet the specifics of the construction project and local requirements while still meeting the provisions of the Loan Agreement.

The Contractor shall, at his expense, furnish and maintain insurance in the form and amounts specified in subparagraphs 1 through 7 inclusive, of this section. Policies shall be with acceptable insurance companies authorized to do business in the State of Ohio.

The Contractor shall not commence Work nor shall he permit any of his Sub-contractors to commence Work until the insurance policies specified hereinafter, or otherwise required, have been submitted to, and approved by the Owner. Such insurance policies shall be kept in force until the Contractor receives final payment.

Insurance shall be endorsed so that it cannot be changed or canceled in less than ten (10) days after receipt by the Contractor and the Owner of written notice of such proposed action from the Insurer.

The insurance specified in Subparagraphs 1, 2, 3 and 4 shall be written under the comprehensive general form of liability insurance contracts.

The Contractor shall furnish three (3) certificates or, whenever specifically requested by the Owner, three (3) certified copies of the insurance policies themselves and a receipt evidencing full payment of the premiums.

In addition to the insurance described hereinafter, the Contractor shall secure and maintain such other insurance as may be designated elsewhere in the Contract document.

If the Contractor is required to repair or perform Work after the completion of the Work involved under this Contract or obtain new policies in accordance with the requirements in this section.

1. *Builders Risk*: In addition to such fire and other physical damage insurance as the Contractor elects to carry for his own protection, he shall also secure and maintain in the name of the Owner, the government agency sponsoring the Project, Subcontractors, the Consulting Engineer and any other parties having an interest in the Project, as named insured as their interest may appear; a builders' risk policy for fire, extended coverage, vandalism and malicious mischief in the amount of one hundred (100) percent of the value of the complete parts of the Project and Materials in storage, except that such coverage shall not be required in connection with sewer, water main or paving construction. Pump or lift station construction shall not be considered sewer or water main construction for purposes of this paragraph.

2. *Workers Compensation*: The Contractor shall provide Workers Compensation Insurance for all employees engaged in Work who may come within the protection of the workers compensation law, and, where applicable, employer's General Liability Insurances for employees not so protected and shall require all Subcontractors to provide corresponding insurance.

The Contractor shall indemnify the Owner and the Consulting Engineer against any and all liabilities, cost and expenses due to accidents or other occurrences covered by the workers compensation law.

3. *Contractor's Motor Vehicle Bodily Injury and Property Damage Liability Insurance*: Insurance to cover liability arising from the use and operation of motor vehicles in connection with the performance of the Contract (as customarily defined in liability insurance policies), whether they be owned, hired or non-owned by the Contractor, as follows:
a. Bodily Injury Liability: $500,000 for each person; limit of $1,000,000 for each occurrence.
b. Property Damage Liability: $500,000 for each occurrence.

4. *Contractor's Public Liability and Property Damage Liability Insurance*: Contractor's Public Liability Insurance providing a limit of not less than $500,000 for all damages arising out of bodily injuries, including accidental death to one person, and a total limit of $1,000,000 for all damages arising out of bodily injuries, including accidental death, to two or more persons in any one occurrence. Contractor's Property Damage Liability Insurance providing for a limit on not less than $500,000 for all damages to or destruction of property.

Coverage under this policy shall include, to the limits indicated above, the collapse or damage to any structure, building or its contents, public or private utility, or pavement during construction and for two (2) years thereafter.

Whenever Work under the Contract is to be done in the vicinity of existing underground utilities or structures, coverage under the policy shall also include, to the limits indicated, all damages to said underground utilities or structures during construction and for a period of two (2) years thereafter. Whenever Work under the Contract is to be done by blasting, coverage under the policy shall also include, to the limits indicated above, all damages of any kind whatsoever caused by blasting.

5. *Contractor's Protective Public Liability and Property Damage Liability Insurance*: Contractor's Protective Public Liability and Property Damage Liability Insurance for operations performed by Subcontractors providing for coverage and limits corresponding to those described in subparagraph 4.

6. *Owner's Protective Public Liability and Property Damage Liability Insurance*: Regular Owner's Protective Public Liability and Property Damage Liability Insurance for operations performed by the Contractor or any Sub-contractor providing for coverage and limits corresponding to those described in subparagraph 4.

This policy shall be written in the name of the Owner as a separate policy from those specified elsewhere herein.

7. *Railroad Protective Liability Insurance*: In any of the Work under this Contract is on railroad R/W, the Contractor shall at its sole cost and expense, procure and provide, for and in behalf of each railroad company. Protective Liability Insurance (AARAASHO form) with minimum limits per occurrence of not less than $2,000,000 for bodily injury, death and/or property damage, subject to an aggregate limit of $6,000,000 per annum. The policy shall name each railroad company as the insured and be issued to the Contractor. Each railroad company shall be provided with a copy of each policy of insurance prior to commencement of any work.

Materials Testing

(Required Contract Provision)

In addition to the details included with specific equipment testing in the specifications, include an overall statement regarding testing for the project. Adjust the following language as needed to meet the specifics of the construction project

Testing Services

1. Contractor shall appoint, employ, and pay for specified services of an independent firm to perform testing.

2. The independent firm will perform tests and other services specified in individual specification sections and as required by the Architect/Engineer.

3. Testing and source quality control may occur on or off the project site. Perform offsite testing as required by the Architect/Engineer or the Owner.

4. Reports will be submitted by the independent firm to the Architect/Engineer and Contractor, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

5. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

   a. Notify Architect/Engineer and independent firm 24 hours prior to expected time for operations requiring services.

   b. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

6. Testing does not relieve Contractor to perform Work to contract requirements.

7. Re-testing required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Architect/Engineer. Payment for re-testing will be charged to the Contractor by deducting testing charges from the Contract Sum/Price.

Continuous Treatment Provisions

(Required Contract Provision)

It is important that construction activities not result in any temporary violations of NPDES permit requirements (for permitted facilities) and construction activities should interrupt wastewater service to the individual resident as little as possible. For drinking water projects, it is important that construction activities not result in any disruption of service. Any disruption of service must be immediately reported to the Ohio EPA, Drinking Water Section of the appropriate district office.

The following example language is a sample of what might be appropriate for construction work occurring at an existing wastewater treatment plant. The language actually incorporated into the contract documents must be adjusted to meet the specifics of the construction project.

Continuous Treatment (wastewater projects)

Federal regulations prohibit by-passing of any sewage during construction operations. The Contractor will be responsible for providing any required temporary pumping facilities piping, etc., necessary to complete the project without any plant by-passing and continuous treatment must be provided at the same level during construction as existed prior to construction.

Unless otherwise previously or subsequently specified, the Contractor shall procure and pay for all permits, licenses, and approvals necessary for the execution of his Contract.

The Contractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work required to complete their Contract.

The following example language is a sample of what might be appropriate for construction work occurring at an existing drinking water treatment plant. The language actually incorporated into the contract documents must be adjusted to meet the specifics of the construction project.

Continuous Treatment (drinking water projects)

The Contractor will be responsible for obtaining approval from Ohio EPA for use of temporary pumping facilities, piping and other items in order to complete the project without any plant by-passing. Continuous treatment must be provided at the same level during construction as existed prior to construction.

Unless otherwise previously or subsequently specified, the Contractor shall procure and pay for all permits, licenses, and approvals necessary for the execution of his Contract.

The Contractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work required to complete their Contract.

State of Ohio

WATER POLLUTION CONTROL LOAN FUND (WPCLF/SRF)

CONTRACT CHANGE ORDER

RECIPIENT _____ CHANGE ORDER NBR _____

LOAN NUMBER _____ CONTRACT _____

OWDA PROJECT No. _____ DATE _____

Description of Change:

RECOMMENDED BY: _____ DATE: _____
(Engineer)

APPROVED BY: _____ DATE: _____
(Recipient)

ACCEPTED BY: _____ DATE: _____
(Contractor)

_____
(Company)

Original Contract Amt		
Previous Changes (+ / --)		
This Change (+ / --)		
Adjusted Contract Amt		

OWDA APPROVAL

The above proposal is hereby accepted and I recommend that it be approved and made a part of the contract noted above. The approval does not constitute an increase in the total loan amount, but represents approval for the work.

Ohio EPA Acceptance

Date

Chief Engineer

Date

State of Ohio

WATER SUPPLY REVOLVING LOAN ACCOUNT (or DWAF)

CONTRACT CHANGE ORDER

RECIPIENT _____ CHANGE ORDER NBR _____

LOAN NUMBER _____ CONTRACT _____

OWDA PROJECT No. _____ DATE _____

Description of Change:

RECOMMENDED BY: _____ DATE: _____
(Engineer)

APPROVED BY: _____ DATE: _____
(Recipient)

ACCEPTED BY: _____ DATE: _____
(Contractor)

_____
(Company)

Original Contract Amt		
Previous Changes (+ / --)		
This Change (+ / --)		
Adjusted Contract Amt		

OWDA APPROVAL

The above proposal is hereby accepted and I recommend that it be approved and made a part of the contract noted above. The approval does not constitute an increase in the total loan amount, but represents approval for the work.

Ohio EPA Acceptance

Date

Chief Engineer

Date

CHANGE ORDER INSTRUCTIONS:

All Change Orders for this work, regardless of costs and whether Water Pollution Control Loan Fund (WPCLF) or Water Supply Revolving Loan Account (WSRLA) funding will be used to finance the changes, must be submitted to Ohio EPA for review.

Changes Requiring Prior Approval

Any change which substantially modifies the Project Facilities as specified in the Ohio EPA approved Facilities Plan and Final Permit to Install or Final Plan Approval (when applicable) or alters the direct or indirect impact of the Project Facilities upon the environment must be incorporated into a Change Order. One copy of the Change Order prior to execution is to be submitted to Ohio EPA for review and prior approval of the acceptability of the change. "Prior to execution" means before the Change Order is signed by the Owner.

Ohio EPA will review the Change Order and inform the Owner of the technical, environmental and operational acceptability of the change, and give the Owner permission to proceed with the proposed work.

All Other Changes

Change Orders not requiring prior approval as described above must be submitted to Ohio EPA within one (1) month of the time at which they are approved by the Owner. Change Orders for WPCLF projects should be submitted to the Division of Environmental and Financial Assistance (DEFA) while Change Orders for WSRLA projects should be submitted to the Division of Drinking and Ground Water (DDAGW) in central office.

Change Order Approval Process

After the Change Order is executed, one (1) copy of the Change Order, including the supporting documentation, is to be sent to Ohio EPA for final review. The WPCLF/WSRLA Change Order forms must have original signatures.

Communities have the option to submit hard copies of the project Change Orders via mail to Ohio EPA or to send PDF Change Order forms and supporting documentation electronically. With either hard copy or electronic submittals, the WPCLF Change Orders should be submitted to DEFA and WSRLA Change Orders should be submitted to DDAGW - Central Office.

The dedicated e-mail address for the electronic submittal of WPCLF Change Orders is EPAWPCLFCO@epa.ohio.gov.

The dedicated e-mail address for the electronic submittal of WSRLA Change Orders is EPAWSRLACO@epa.ohio.gov.

After the Change Order is accepted and eligible costs determined, Ohio EPA will issue a letter informing the Owner and authorizing OWDA to disburse funds from Project Contingency for the work. The OEPA letter will be sent electronically. OWDA will return a PDF of the WPCLF/WSRLA Change Order form which will be signed by all parties including Ohio EPA and OWDA.

Please notify Ohio EPA if the community prefers a hard copy of change order approval documentation and then Ohio EPA and OWDA will send hard copies of approval documentation through the mail.

Payments for Change Order Work

The Owner is precluded from submitting to the OWDA payment requests for Eligible Project Costs associated with the Change Orders until such time as the Ohio EPA's approval of the Change Orders has been obtained.

Local Protest Procedure

(suggested contract provision)

Some statement as to when a valid protest must be filed, in what form it must be filed and who it must be filed with should be included. ORC 153.12 has some default procedures for handling WPCLF and disputes. If the owner wants more control than provided in ORC, a procedure needs to be spelled out in the Contract Documents.

The following example language is a sample of language that could be included. Review all local procedures and requirements and adjust the language to meet the specifics of the project.

Protests

A protest based upon an alleged violation of the procurement requirement may be filed against the OWNER's procurement action by a party with an adversely affected direct financial interest. The protest shall be filed with the Mayor. The OWNER shall determine the protest. The OWNER may request additional information or a hearing in order to resolve the protest.

A protest shall be filed as early as possible during the procurement process, but must be received by the OWNER no later than one week after the basis of the protest is known or should have been known, whichever is earlier. If the protest is mailed, the protester bears the risk of nondelivery with in the required time period.

A protest must clearly present the procurement requirement being protested, the facts which support the protest, and any other information necessary to support the protest.

Basis And Method For Award

(suggested contract provision)

The contract documents should include some language that clearly states what the Owner will consider when determining the successful bidder and to provide a clear basis for the Owner when they have a need to reject the low bidder and go with a different bidder.

The following example language is a sample of language that could be included. Review all local procedures and requirements and adjust the language to meet the specifics of the project.

Basis for Award

1. Owner reserves the right to reject any and all Bids, to waive any and all informalities and to negotiate contract terms with the successful Bidder, and the right to disregard all nonconforming, nonresponsive or conditional bids. Discrepancies between words and figures will be resolved in favor of words. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

2. In evaluating Bids, Owners shall consider the qualifications of the Bidder, whether or not the Bids comply with the prescribed requirements and alternates and unit prices if requested in the Bid forms. The Owner intends to accept alternates (if any are accepted) in the order in which they are listed in the Bid Form but Owner may accept them in any order or combination.

3. Owner may consider the qualifications and experience of Subcontractors and other persons and organizations (including those who are to furnish the principle items of material or equipment) proposed for those portions of the work as to which the identity of Subcontractors and other persons and organizations must submitted as provided in the Supplementary Conditions. Operating costs, maintenance considerations, performance data and guarantees of materials and equipment may also be considered by Owner.

4. Owner may conduct investigations he deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of the Bidders, proposed Subcontractors, and other persons and organizations to do the Work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.

5. Owner reserves the right to reject the Bid of any Bidder who does not pass investigation of evaluation to Owner's satisfaction. Owner may reject any Proposal where the unit price or individual lump sum prices are unbalanced and/or unfavorable to the Owner's interest.

6. Owner will not make any award or permit any award at any tier to any party which is debarred or suspended or is otherwise excluded from or ineligible for participation in Federal assistance programs under Executive Order 12549 "Debarment and Suspension." Each Contractor and supplier (over $25,000) shall complete the Certification Regarding Debarment, Suspension, and Other Responsibility Matters.

7. If Contract is awarded, it will be awarded to the lowest responsive responsible Bidder whose evaluation by Owner indicates to Owner that the award will be in the best interest of the Project.

8. If the contract is awarded, Owner will give the Successful Bidder a Notice of Award within the time stated in the Advertisement after the day of the Bid opening.

9. When owner gives a Notice of Award to the Successful Bidder, it will be accompanied by at least three unsigned counterparts of the Agreement and three copies of all other Contract Documents. Within ten days thereafter, Contractor shall sign and deliver at least three counterparts of the Agreement to Owner with three copies of all other Contract Documents attached. Within fifteen days thereafter, Owner will deliver one copy of all fully signed counterparts to Contractor.

Payment Methods

(suggested contract provision)

To minimize uncertainty and arguments that can slow down the progress of construction it is useful to provide language stating how and when the Contractor will get paid. In addition to ORC and other local requirements, the involvement of public funding Agencies such as the WPCLF, Ohio Public Works Commission and Community Development Block Grant impact the process and timing for payments.

The following example language is a sample of language that could be included. Review all local procedures and requirements and adjust the language to meet the specifics of the project.

1. At least ten (10) days before each progress payment falls due (but not more often than once a month), the Contractor will submit to the Engineer a partial payment estimated filled out and signed by the Contractor covering the work performed during the period covered by the partial payment estimate and supported by such data as the Engineer may reasonably require. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitable stored at or near the site, the partial payment estimate shall also be accompanied by such supporting data, satisfactory to the Owner as will establish the Owner's title to the material and equipment and protect his interest therein, including applicable insurance. The Engineer will, with ten (10) days after receipt of each partial payment estimate, either indicate in writing his approval of payment and present the partial payment estimate to the Owner, or return the partial payment estimate to the Contractor indicating in writing his reason for refusing to approve payment.

   In the latter case, the Contractor may make the necessary corrections and resubmit the partial payment estimate. The Owner will, within 30 days of presentation to him of an approved partial payment estimate, pay Contractor for labor performed and material incorporated in the Work, at the rate of 92 percent of the amount of the estimate as approved by the Engineer until 50 percent of the Work is completed. All labor performed and material incorporated in the Work after the job is 50 percent of completed shall be paid for at the rate of 100 percent of the amount of additional labor and material furnished and approved and the amount labor and material furnished and approved the amount previously retained shall be deposited in an escrow account. The funds in the escrow account with accumulated interest are to be paid the Contractor at the same time and in the same manner as specified for payment of the of the retained amount in Section 5.

   Payment for material and equipment delivered and not incorporated shall be based on the scheduled of quantities and cost submitted. Any money due from Owner shall, on the day that it is due, be paid to Contractor, or deposited in an escrow account, whichever is applicable, with one or mare banks or building and loan associations in the state selected by mutual agreement between the Contractor and the Owner. The agreement shall contain the following provisions:

   A. The money shall be deposited in a savings account or the escrow agent shall property invest the entire escrow principal in obligations selected by the escrow agent, as stipulated in the agreement.

   B. The escrow agent shall hold the escrow principal and income until receipt of notice from the Owner and the Contractor, of until receipt of an arbitration order specifying the amount of escrow principal to be released and the person to whom it is to be released. Upon receipt of

the notice or order, the agent shall properly pay such amount of principal and the portion of amount of the escrow income to the person indicated.

C. The escrow agent shall be compensated for its services as agreed to by the Owner and the Contractor from the income from the escrow account.

2. The request for payment may also include an allowance for the cost of such major material and equipment which are suitably stored either at the site or the near the site.

WPCLF/WSRLA CONTRACT DOCUMENTS REVIEW

Funding Applicant:	
Project Name:	**Project Number:**
Date Bid Advertisement will start:	**Date Bids will be opened:**
Engineer's estimate of construction cost:	
Time of completion for work (e.g., 9 months):	

Please provide the Section/Page number from the contract documents that corresponds with each item below.

Program Requirements -Any item checked as "No" must be explained on a separate sheet

☐ Yes ☐ No EEO Certification *Section/Page #*_____
☐ Yes ☐ No Certification Regarding Debarment & Suspension *Section/Page #*_____
☐ Yes ☐ No Contract provisions describing DBE requirements *Section/Page #*_____
☐ Yes ☐ No DBE Forms 6100-3, 6100-4 and 6100- 2 *Section/Page #*_____
☐ Yes ☐ No Davis-Bacon wage rate requirements *Section/Page #*_____
☐ Yes ☐ No American Iron and Steel Acknowledgement Form *Section/Page #*_____
☐ Yes ☐ No Violating Facilities clause *Section/Page #*_____
☐ Yes ☐ No Small Businesses in Rural Areas (SBRA) *Section/Page #*_____
☐ Yes ☐ No Insurance Provisions for both the contractor and all subcontractors:
- ☐ Yes ☐ No Workers' Compensation
- ☐ Yes ☐ No Public Liability
- ☐ Yes ☐ No Property Damage
- ☐ Yes ☐ No Vehicle Liability
- ☐ Yes ☐ No Flood (if appropriate)
- ☐ Yes ☐ No Builders Risk (can be held by owner instead)

☐ Yes ☐ No Material Testing (statement regarding testing for specifications) *Section/Page #*_____
☐ Yes ☐ No Project-specific continuous service/treatment provisions *Section/Page #*_____
☐ Yes ☐ No WPCLF/WSRLA Change Order form & instructions *Section/Page #*_____
☐ Yes ☐ No Bid proposal forms (necessary for determining loan eligibility) *Section/Page #*_____

Other Contract Requirements

☐ N/A - superseded by local requirements
☐ Yes ☐ No Text of the bid advertisement *Section/Page #*_____
☐ Yes ☐ No Engineer's estimate of cost for construction *Section/Page #*_____
☐ Yes ☐ No Description of how the bid price, including any alternates, is determined *Section/Page #*_____
☐ Yes ☐ No Notice to Proceed form *Section/Page #*_____
☐ Yes ☐ No Any material or equipment designated from a "sole source?" *Section/Page #*_____
If yes, attach a description and justification for each item.
☐ Yes ☐ No Bid includes a dedicated contract contingency/allowance amount *Section/Page #*_____
Contract contingency is ☐ a fixed dollar amount ☐ a fixed percentage of the contract total

Ohio Revised Code Requirements - The following are required for municipalities (cities, villages, counties, sewer districts) but may be superseded by local charter or other local requirements.

☐ N/A - superseded by local requirements ☐ N/A - not a municipality
☐ Yes ☐ No Bid Guarantee in the form required by ORC *Section/Page #*_____
☐ Yes ☐ No Payment and Performance Bonds in the form required by ORC *Section/Page #*_____
☐ Yes ☐ No Provisions for payment retention in conformance with ORC *Section/Page #*_____
☐ Yes ☐ No A specific time for completion of the work *Section/Page #*_____

Checklist Prepared by:_____ Phone or E-mail _____

Bid Package Submittals

The following documents must be submitted to Ohio EPA – DEFA within one week after bids are received, or sooner dependent on your individual project schedule.

1. One copy of all addenda when they are issued.

2. A complete copy of the successful bidder's proposal(s).

3. A bid tabulation (a list of all bidders and their line item amounts) in the same format as the proposal.

4. The engineer's bid evaluation and recommendation.

5. A signed copy of the Contractor's EEO Certification Form

6. A signed copy of the Certification Regarding Debarment, Suspension, and Other Responsibility Matters.

7. Completed copies of Form 6100-3 Individual DBE Subcontractor Proposed Performance Form and Form 6100-4 DBE Subcontractor Utilization Summary that were provided by the successful bidder(s), as well as any alternate "good faith efforts" documentation.

8. A resolution from the loan recipient's governing body tentatively awarding the contract to the successful bidder.

9. A copy of the site title opinion stating that all sites, easements and / or right-of-way necessary to construct the project have been acquired.

10. Signed American Iron and Steel Acknowledgement Form.

SECTION 00 4519

NON-COLLUSION AFFIDAVIT

(This Affidavit is part of the Proposal)

STATE OF _____

COUNTY OF _____

_____ being first duly sworn, deposes and says that he is

_____
(President, Secretary, etc.)
of the party who made the foregoing proposal, that such proposal was genuine and not collusive, that said Bidder did not collude, conspire, connive, or agree, directly or indirectly, with any bidder or person, that such other person should refrain from bidding, or submit a sham bid and did not, in any manner, directly or indirectly, seek by agreement or collusion, or communication or conference with any person, to fix the bid price of Affiant or any other bidder, or to fix any overhead, profit or cost element of said bid price, or of that of any other bidder, or to secure any advantage against the _____ or any person interested in the proposed contract, and that all statements contained in said Proposal are true and further, that such Bidder did not, directly or indirectly, submit this Proposal, or the contents thereof, or divulge information or data relative thereto, to any association or to any member or agent thereof.

_____
AFFIANT

Sworn to and subscribed before me this _____ day of _____, 20 ____

_____
NOTARY PUBLIC IN AND FOR

_____County, _____

My Commission expires _____, _____, 20_____

(SEAL)

END OF SECTION 00 4519

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SECTION 00 4529

PERSONAL PROPERTY TAX DISCLOSURE AFFIDAVIT

THIS SECTION SHOULD BE FULLY COMPLETED WHETHER OR NOT YOU AS A VENDOR/ CONTRACTOR OWN PROPERTY IN WARREN COUNTY, OHIO. MAKING A FALSE STATEMENT ON THIS AFFIDAVIT MAY BE PUNISHABLE BY A FINE AND/OR IMPRISONMENT.

STATE OF _____

COUNTY OF _____

_____, being duly cautioned and sworn, states as follows:

1. That he is _____ of
   (Title)

   _____
   (Name of Contracting Party)
2. That _____ is not presently charged with any
   (Name of Contracting Party)
   delinquent Real and/or Personal property taxes on the general tax list of Real and/or Personal property of Warren County.

   -OR-

1. That _____ is charged with delinquent Real and/or
   (Name of Contracting Party)
   Personal property tax on the general tax list of Real and/or Personal property of Warren County. The amount of delinquent Real and/or Personal property tax due and unpaid including any due and unpaid penalty and interest is:
   $_____

Furthermore, affiant states not.

_____
Affiant

Sworn to and subscribed in my presense this _____ day of _____, 20_____

_____
Notary Public

This instrument was prepared by _____

END OF SECTION 00 4529

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SECTION 00 4539

FINDINGS FOR RECOVERY AFFIDAVIT

STATE OF_____

COUNTY OF_____, SS:

_____, upon being duly cautioned and sworn, hereby states the following based on personal knowledge:

1) That he/she is_____(title), of _____(name of bidder) and authorized to execute this affidavit; and,

2) That _____ (name of bidder) is not a person or entity against whom a finding for recovery has been issued by the Auditor of State, which finding for recovery is unresolved as defined in Ohio Revised Code [General Provisions] Section 9.24 (B); and,

3) That _____ (name of bidder) does not appear in the database of unresolved findings of recovery maintained by the Auditor of State pursuant to Ohio Revised Code [General Provisions] Section 9.24 (D).

_____

Affiant

Sworn to and subscribed in my presence this _____day of _____, 2020.

_____

Notary Public

My Commission expires: _____

END OF SECTION 00 4539

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SECTION 00 5100

NOTICE OF AWARD

To: _____

_____

_____

PROJECT DESCRIPTION: The project consists of the construction of a membrane softening addition to the existing Richard A. Renneker Water Treatment Plant to treat 13.7 MGD (expandable to 22.0 MGD) of groundwater. Improvements include a new nanofiltration softening building complete with NF softening equipment, pumps, process piping, valves, deasifiers, chemical feed systems, and all associated architectural, structural, HVAC, plumbing, electrical, instrumentation and controls work shown on the plans.

The OWNER has considered the BID submitted by you for the above described WORK in response to its Advertisement For Bids dated _____ and Instructions to Bidders.

You are hereby notified that your BID has been accepted in the amount of $_____.

You are required by the Instructions to Bidders to execute the Agreement and furnish the required CONTRACTOR'S Performance BOND, Payment BOND and certificates of insurance within fifteen (15) calendar days from the date of receipt of this Notice by you.

If you fail to execute said Agreement and to furnish said BONDS within fifteen (15) days from the date of receipt of this Notice, said OWNER will be entitled to consider all your rights arising out of the OWNER's acceptance of your BID as abandoned and as a forfeiture of your BID BOND. The OWNER will be entitled to such other rights as may be granted by law. You are required to return an acknowledged copy of this NOTICE OF AWARD to the OWNER.

Dated this _____ day of _____ , 20 _____

For Warren County Board of Commissioners

By _____

Title _____

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE OF AWARD is hereby acknowledged

by _____

this the _____ day of _____ , 20 ____

By _____

Title _____

END OF SECTION 00 5100

SECTION 00 5215

AGREEMENT BETWEEN OWNER AND CONTRACTOR

THIS AGREEMENT made this _____ day of _____ , 20_____ with the Warren County Board of Commissioners, 406 Justice Drive, Lebanon, Ohio, hereinafter called "OWNER" and _____, doing business as (an individual, a partnership, or a corporation) called "CONTRACTOR".

WITNESSETH: That for and in consideration of the payments and agreements hereinafter mentioned, to be performed by the Owner, the Contractor herby agrees with the Owner to commence and complete the construction described as follows:

RARWTP MEMBRANE SOFTENING UPGRADES

hereinafter called the project, for the sum of $ *(Contractors Bid Price)* and all work in connection therewith, under the terms as stated in the Conditions of the Contract; and as his (its or their) own proper cost and expense furnish all the materials, supplies, machinery, equipment, tools, superintendence, labor insurance, and other accessories and services necessary to complete the said project in accordance with the conditions and prices stated in the Proposal, Conditions of the Contract, the Specifications, and Contract Documents. "Contract Documents" means the following:

(A) ADVERTISEMENT FOR BIDS
(B) INSTRUCTIONS TO BIDDERS
(C) BID
(D) BID SECURITY
(E) AGREEMENT
(F) GENERAL CONDITIONS
(G) SUPPLEMENTARY CONDITIONS
(H) CONTRACT BOND (PERFORMANCE AND PAYMENT BONDS)
(I) NOTICE OF AWARD
(J) NOTICE TO PROCEED
(K) CHANGE ORDER
(L) DRAWINGS prepared or issued by AECOM.
(M) SPECIFICATIONS prepared or issued by AECOM.
(N) ADDENDUM

CONTRACTOR hereby agrees to commence work under this contract on or before a date to be specified in the NOTICE TO PROCEED of the OWNER and shall substantially complete the Contract Work within five hundred forty-eight (548) calendar days and fully complete the Contract Work in its entirety within six hundred forty (640) calendar days after the date of the NOTICE TO PROCEED unless the period for completion is extended otherwise by the CONRACT DOCUMENTS.

CONTRACTOR also agrees to pay as liquidated damages, the amounts as stated in the SUPPLEMENTARY GENERAL CONDITIONS.

This Agreement may be terminated by either party upon written notice in the event of substantial failure by the other party to perform in accordance with the terms of this Agreement. The nonperforming party

shall have fifteen calendar days from the date of the termination notice to cure or to submit a plan for cure acceptable to the other party.

OWNER may terminate or suspend performance of this Agreement for OWNER'S convenience upon written notice to the CONTRACTOR. CONTRACTOR shall terminate or suspend performance of the services/work on a schedule acceptable to the OWNER.

The CONTRACTOR will indemnify and save the OWNER, their officers and employees, harmless from loss, expenses, costs, reasonable attorney's fees, litigation expenses, suits at law or in equity, causes of action, actions, damages, and obligations arising from (a) negligent, reckless or willful and wanton acts, errors or omissions by CONTRACTOR, its agents, employees, licensees, consultants, or subconsultants; (b) the failure of the CONTRACTOR, its agents, employees, licensees, consultants or subconsultants to observe the applicable standard of care in providing services pursuant to this agreement; (c) the intentional misconduct of the CONTRACTOR, its agents, employees, licensees, consultants, or subconsultants that result in injury to persons or damage to property for which the OWNER may be held legally liable.

The CONTRACTOR does hereby agree to indemnify and hold the OWNER harmless for any and all sums for which the OWNER may be required to pay or for which the OWNER may be held responsible for failure of the CONTRACTOR or any subcontractors to pay the prevailing wage upon this project.

The OWNER agrees to pay the CONTRACTOR in the manner and at such times as set forth in the General Provisions such amounts as required by the Contract Documents.

This Agreement shall be construed under the laws of the State of Ohio, and the parties hereby stipulate to the venue for any and all claims, disputes, interpretations, litigation of any kind arising out of this Agreement being exclusively in the Warren County, Ohio Court of Common Pleas (unless both parties mutually agree in writing to alternate dispute resolution), as well as waiving any right to bring or remove such matters in or to any other state or federal court.

This Agreement shall be binding upon all parties hereto and their respective heirs, executors, administrators, successors, and assigns.

CONTRACTOR shall bind every subcontractor to, and every subcontractor must agree to be bound by the terms of, this Agreement, as far as applicable to the subcontractor's work particularly pertaining to Prevailing Wages and EEO requirements. Nothing contained in this Agreement shall create any contractual relationship between any subcontractor and Owner, nor create any obligations on the part of the Owner to pay or see to the payment of any sums to any subcontractor.

IN WITNESS WHEREOF, the parties hereto have executed, or caused to be executed by their duly authorized officials, this Agreement in three (3) counterparts, each of which shall be deemed an original on the date first above written.

Warren County Board of Commissioners
Owner

ATTEST:

By: _____

Name: _____
(Print)

Title: _____

By: _____

Name: _____
(Print)

Title: _____

By: _____

Name: _____
(Print)

Title: _____

By: _____

Name: _____
(Print)

Title: _____

APPROVED AS TO FORM:

By: _____

Name: _____
(Print)

Title: _____

CONTRACTOR:

ATTEST:

By: _____ By: _____

Name _____ Name: _____
Print (Print)

Title: _____ Title: _____

END OF SECTION 00 5215

SECTION 00 5500

NOTICE TO PROCEED

To: _____ Date: _____

Project: Richard A. Renneker Water Treatment Plant (RARWTP) Membrane Softening Upgrades

_____

_____

_____

You are hereby notified to commence WORK in accordance with the Agreement dated _____, 20_____, on or before _____, 20____, and you are to complete the WORK within the Contract time set forth in the Contract Documents. Therefore, the date of substantial completion is _____, 20____, and the date of final completion of all WORK is _____, 20____.

Warren County Board of Commissioners
Owner

By: _____

Title: _____

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE TO PROCEED is hereby acknowledged by

_____, this the ____ day of _____, 20____.

By: _____

Title: _____

END OF SECTION 00 5500

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SECTION 00 6113.13

PERFORMANCE BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (*Name and Address*): SURETY (*Name, and Address of Principal Place of Business*):

OWNER (*Name and Address*):

CONTRACT
Effective Date of Agreement:
Amount:
Description (*Name and Location*):

BOND
Bond Number:
Date (*Not earlier than Effective Date of Agreement*):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	**SURETY**
_____ (Seal)	_____ (Seal)
Contractor's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
_____	_____
Title	Title

Note: Provide execution by additional parties, such as joint venturers, if necessary.

Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner for the performance of the Contract, which is incorporated herein by reference.

1. If Contractor performs the Contract, Surety and Contractor have no obligation under this Bond, except to participate in conferences as provided in Paragraph 2.1.

2. If there is no Owner Default, Surety's obligation under this Bond shall arise after:
   2.1 Owner has notified Contractor and Surety, at the addresses described in Paragraph 9 below, that Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with Contractor and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. If Owner, Contractor, and Surety agree, Contractor shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Owner's right, if any, subsequently to declare a Contractor Default; and
   2.2 Owner has declared a Contractor Default and formally terminated Contractor's right to complete the Contract. Such Contractor Default shall not be declared earlier than 20 days after Contractor and Surety have received notice as provided in Paragraph 2.1; and
   2.3 Owner has agreed to pay the Balance of the Contract Price to:
      1. Surety in accordance with the terms of the Contract; or
      2. Another contractor selected pursuant to Paragraph 3.3 to perform the Contract.

3. When Owner has satisfied the conditions of Paragraph 2, Surety shall promptly, and at Surety's expense, take one of the following actions:

   3.1 Arrange for Contractor, with consent of Owner, to perform and complete the Contract; or
   3.2 Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or
   3.3 Obtain bids or negotiated proposals from qualified contractors acceptable to Owner for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Owner and contractor selected with Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Contract, and pay to Owner the amount of damages as described in Paragraph 5 in excess of the Balance of the Contract Price incurred by Owner resulting from Contractor Default; or
   3.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:
      1. After investigation, determine the amount for which it may be liable to Owner and, as soon as practicable after the amount is determined, tender payment therefor to Owner; or
      2. Deny liability in whole or in part and notify Owner citing reasons therefor.

4. If Surety does not proceed as provided in Paragraph 3 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Owner to Surety demanding that Surety perform its obligations under this Bond, and Owner shall be entitled to enforce any remedy available to Owner. If Surety proceeds as provided in Paragraph 3.4, and Owner refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Owner shall be entitled to enforce any remedy available to Owner.

5. After Owner has terminated Contractor's right to complete the Contract, and if Surety elects to act under Paragraph 3.1, 3.2, or 3.3 above, then the responsibilities of Surety to Owner shall not be greater than those of Contractor under the Contract, and the responsibilities of Owner to Surety shall not be greater than those of Owner under the Contract. To the limit of the amount of this Bond, but subject to commitment by Owner of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

5.1 The responsibilities of Contractor for correction of defective Work and completion of the Contract;
5.2 Additional legal, design professional, and delay costs resulting from Contractor's Default, and resulting from the actions of or failure to act of Surety under Paragraph 3; and
5.3 Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Contractor.

6. Surety shall not be liable to Owner or others for obligations of Contractor that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Owner or its heirs, executors, administrators, or successors.

7. Surety hereby waives notice of any change, including changes of time, to Contract or to related subcontracts, purchase orders, and other obligations.

8. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located, and shall be instituted within two years after Contractor Default or within two years after Contractor ceased working or within two years after Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

9. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the address shown on the signature page.

10. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

11. Definitions.

11.1 Balance of the Contract Price: The total amount payable by Owner to Contractor under the Contract after all proper adjustments have been made, including allowance to Contractor of any amounts received or to be received by Owner in settlement of insurance or other Claims for damages to which Contractor is entitled, reduced by all valid and proper payments made to or on behalf of Contractor under the Contract.
11.2 Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.
11.3 Contractor Default: Failure of Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.
11.4 Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or otherwise comply with the other terms thereof.

FOR INFORMATION ONLY – (*Name, Address and Telephone*) Surety Agency or Broker: Owner's Representative (*Engineer or other party*):

END OF SECTION 00 6113.13

SECTION 00 6113.16

PAYMENT BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (*Name and Address*):

SURETY (*Name, and Address of Principal Place of Business*):

OWNER (*Name and Address*):

CONTRACT

Effective Date of Agreement:
Amount:
Description *(Name and Location)*:

BOND

Bond Number:
Date (*Not earlier than Effective Date of Agreement*):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	**SURETY**
_____ (Seal)	_____ (Seal)
Contractor's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
_____	_____
Title	Title

Note: Provide execution by additional parties, such as joint venturers, if necessary.

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to Owner, this obligation shall be null and void if Contractor:

2.1 Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2 Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.

3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

4.1 Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2 Claimants who do not have a direct contract with Contractor:

1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and
2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and
3. Not having been paid within the above 30 days, have sent a written notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.

5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.

6. When a Claimant has satisfied the conditions of Paragraph 4, the Surety shall promptly and at Surety's expense take the following actions:

6.1 Send an answer to that Claimant, with a copy to Owner, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed.

6.2 Pay or arrange for payment of any undisputed amounts.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.

9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders, and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner, or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. Definitions

15.1 Claimant: An individual or entity having a direct contract with Contractor, or with a first-tier subcontractor of Contractor, to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms “labor, materials or equipment” that part of water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and Contractor’s subcontractors, and all other items for which a mechanic’s lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

15.2 Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

15.3 Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract, or to perform and complete or otherwise comply with the other terms thereof.

END OF SECTION 00 6113.16

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SECTION 00 7000

GENERAL CONDITIONS

Following is Standard General Conditions of the Construction Contract (NSPE – EJCDC C-700, 2007 Edition).

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Engineers Joint Documents Committee
Design and Construction Related Documents
Instructions and License Agreement

Instructions

Before you use any EJCDC document:

1. Read the License Agreement. You agree to it and are bound by its terms when you use the EJCDC document.

2. Make sure that you have the correct version for your word processing software.

How to Use:

1. While EJCDC has expended considerable effort to make the software translations exact, it can be that a few document controls (e.g., bold, underline) did not carry over.

2. Similarly, your software may change the font specification if the font is not available in your system. It will choose a font that is close in appearance. In this event, the pagination may not match the control set.

3. If you modify the document, you must follow the instructions in the License Agreement about notification.

4. Also note the instruction in the License Agreement about the EJCDC copyright.

License Agreement

You should carefully read the following terms and conditions before using this document. Commencement of use of this document indicates your acceptance of these terms and conditions. If you do not agree to them, you should promptly return the materials to the vendor, and your money will be refunded.

The Engineers Joint Contract Documents Committee ("EJCDC") provides **EJCDC Design and Construction Related Documents** and licenses their use worldwide. You assume sole responsibility for the selection of specific documents or portions thereof to achieve your intended results, and for the installation, use, and results obtained from **EJCDC Design and Construction Related Documents**.

You acknowledge that you understand that the text of the contract documents of **EJCDC Design and Construction Related Documents** has important legal consequences and that consultation with an attorney is recommended with respect to use or modification of the text. You further acknowledge that EJCDC documents are protected by the copyright laws of the United States.

License:

You have a limited nonexclusive license to:

1. Use **EJCDC Design and Construction Related Documents** on any number of machines owned, leased or rented by your company or organization.

2. Use **EJCDC Design and Construction Related Documents** in printed form for bona fide contract documents.

3. Copy **EJCDC Design and Construction Related Documents** into any machine readable or printed form for backup or modification purposes in support of your use of **EJCDC Design and Construction Related Documents**.

You agree that you will:

1. Reproduce and include EJCDC's copyright notice on any printed or machine-readable copy, modification, or portion merged into another document or program. All proprietary rights in **EJCDC Design and Construction Related Documents** are and shall remain the property of EJCDC.

2. Not represent that any of the contract documents you generate from **EJCDC Design and Construction Related Documents** are EJCDC documents unless (i) the document text is used without alteration or (ii) all additions and changes to, and deletions from, the text are clearly shown.

You may not use, copy, modify, or transfer EJCDC Design and Construction Related Documents, or any copy, modification or merged portion, in whole or in part, except as expressly provided for in this license. Reproduction of EJCDC Design and Construction Related Documents in printed or machine-readable format for resale or educational purposes is expressly prohibited.

If you transfer possession of any copy, modification or merged portion of EJCDC Design and Construction Related Documents to another party, your license is automatically terminated.

Term:

The license is effective until terminated. You may terminate it at any time by destroying **EJCDC Design and Construction Related Documents** altogether with all copies, modifications and merged portions in any form. It will also terminate upon conditions set forth elsewhere in this Agreement or if you fail to comply with any term or condition of this Agreement. You agree upon such termination to destroy **EJCDC Design and Construction Related Documents** along with all copies, modifications and merged portions in any form.

Limited Warranty:
EJCDC warrants the CDs and diskettes on which **EJCDC Design and Construction Related Documents** is furnished to be free from defects in materials and workmanship under normal use for a period of ninety (90) days from the date of delivery to you as evidenced by a copy of your receipt.

There is no other warranty of any kind, either expressed or implied, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

EJCDC does not warrant that the functions contained in **EJCDC Design and Construction Related Documents** will meet your requirements or that the operation of **EJCDC Design and Construction Related Documents** will be uninterrupted or error free.

Limitations of Remedies:
EJCDC's entire liability and your exclusive remedy shall be:

1. the replacement of any document not meeting EJCDC's "Limited Warranty" which is returned to EJCDC's selling agent with a copy of your receipt, or

2. if EJCDC's selling agent is unable to deliver a replacement CD or diskette which is free of defects in materials and workmanship, you may terminate this Agreement by returning EJCDC Document and your money will be refunded.

In no event will EJCDC be liable to you for any damages, including any lost profits, lost savings or other incidental or consequential damages arising out of the use or inability to use **EJCDC Design and Construction Related Documents** even if EJCDC has been advised of the possibility of such damages, or for any claim by any other party.

Some states do not allow the limitation or exclusion of liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you.

General:
You may not sublicense, assign, or transfer this license except as expressly provided in this Agreement. Any attempt otherwise to sublicense, assign, or transfer any of the rights, duties, or obligations hereunder is void.

This Agreement shall be governed by the laws of the State of Virginia. Should you have any questions concerning this Agreement, you may contact EJCDC by writing to:

Arthur Schwartz, Esq.
General Counsel
National Society of Professional Engineers
1420 King Street
Alexandria, VA 22314

Phone: (703) 684-2845
Fax: (703) 836-4875
e-mail: aschwartz@nspe.org

You acknowledge that you have read this agreement, understand it and agree to be bound by its terms and conditions. You further agree that it is the complete and exclusive statement of the agreement between us which supersedes any proposal or prior agreement, oral or written, and any other communications between us relating to the subject matter of this agreement.

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

ACEC
American Council of Engineering Companies

The Associated General Contractors of America — Skill, Responsibility, Integrity

ASCE American Society of Civil Engineers

National Society of Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

AMERICAN SOCIETY OF CIVIL ENGINEERS

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A Practice Division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Endorsed by

CONSTRUCTION SPECIFICATIONS INSTITUTE

These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor (EJCDC C-520 or C-525, 2007 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the Narrative Guide to the EJCDC Construction Documents (EJCDC C-001, 2007 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (EJCDC C-800, 2007 Edition).

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Asbestos*—Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. *Bid*—The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

6. *Bidder*—The individual or entity who submits a Bid directly to Owner.

7. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).

8. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.

9. *Change Order*—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

10. *Claim*—A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*—The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

13. *Contract Price*—The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

14. *Contract Times*—The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any; (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.

15. *Contractor*—The individual or entity with whom Owner has entered into the Agreement.

16. *Cost of the Work*—See Paragraph 11.01 for definition.

17. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

18. *Effective Date of the Agreement*—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

19. *Engineer*—The individual or entity named as such in the Agreement.

20. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.

21. *General Requirements*—Sections of Division 1 of the Specifications.

22. *Hazardous Environmental Condition*—The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto.

23. *Hazardous Waste*—The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

24. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

25. *Liens*—Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *Milestone*—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. *Notice of Award*—The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.

28. *Notice to Proceed*—A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

29. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

30. *PCBs*—Polychlorinated biphenyls.

31. *Petroleum*—Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

32. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

33. *Project*—The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. *Project Manual*—The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

35. *Radioactive Material*—Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

36. *Resident Project Representative*—The authorized representative of Engineer who may be assigned to the Site or any part thereof.

37. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

38. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

39. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

40. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

41. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.

42. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

43. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

44. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

45. *Successful Bidder*—The Bidder submitting a responsive Bid to whom Owner makes an award.

46. *Supplementary Conditions*—That part of the Contract Documents which amends or supplements these General Conditions.

47. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or Subcontractor.

48. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

49. *Unit Price Work*—Work to be paid for on the basis of unit prices.

50. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

51. *Work Change Directive*—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an

addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

A. The words and terms discussed in Paragraph 1.02.B through F are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives:*

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. *Day:*

1. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective:*

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents; or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

c. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. *Furnish, Install, Perform, Provide:*

1. The word "furnish," when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When "furnish," "install," "perform," or "provide" is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.04 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.07 *Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of

the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner.

C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 *Reference Standards*

A. Standards, Specifications, Codes, Laws, and Regulations

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard, specification, manual, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

1. *Contractor's Review of Contract Documents Before Starting Work*: Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. *Contractor's Review of Contract Documents During Performance of Work*: If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation , (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies:*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

a. the provisions of any standard, specification, manual, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference in the Contract Documents); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions; or

2. reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

A. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the

Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and

2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 *Differing Subsurface or Physical Conditions*

A. *Notice:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

1. is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *Engineer's Review*: After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner's obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer's findings and conclusions.

C. *Possible Price and Times Adjustments:*

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

   a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and

   b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:

   a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

   b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or

   c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other

professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

a. reviewing and checking all such information and data;

b. locating all Underground Facilities shown or indicated in the Contract Documents;

c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction; and

d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated:*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price

or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 *Hazardous Environmental Condition at Site*

A. *Reports and Drawings:* The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.

D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by

Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.

E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered written notice to Contractor: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.

F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.

G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.

C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

A. Contractor shall deliver to Owner, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.

B. Owner shall deliver to Contractor, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.

C. Failure of Owner to demand such certificates or other evidence of Contractor's full compliance with these insurance requirements or failure of Owner to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Contractor's obligation to maintain such insurance.

D. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor.

E. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

5.04 *Contractor's Insurance*

A. Contractor shall purchase and maintain such insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:

   a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or

   b. by any other person for any other reason;

5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

3. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;

4. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

5. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

6. include completed operations coverage:

    a. Such insurance shall remain in effect for two years after final payment.

    b. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 *Owner's Liability Insurance*

A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

A. Unless otherwise provided in the Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;

2. be written on a Builder's Risk "all-risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions.

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup; and

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued.

B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other loss payee to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property

insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under this Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. Prior to commencement of the Work at the Site, Owner shall in writing advise Contractor whether or not such other insurance has been procured by Owner.

5.07 *Waiver of Rights*

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery

against Contractor, Subcontractors, or Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the loss payees, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.

B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

6.02 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05 *Substitutes and "Or-Equals"*

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.

1. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and

3) it has a proven record of performance and availability of responsive service.

b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. *Substitute Items:*

a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

b. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.

d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

1) shall certify that the proposed substitute item will:

a) perform adequately the functions and achieve the results called for by the general design,

b) be similar in substance to that specified, and

c) be suited to the same use as that specified;

2) will state:

a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time,

b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and

c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified, and

b) available engineering, sales, maintenance, repair, and replacement services; and

4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.

B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.

D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

E. *Engineer's Cost Reimbursement*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

F. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 *Concerning Subcontractors, Suppliers, and Others*

A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or

other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

   1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity; nor

   2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.08 *Permits*

A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all

court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

6.11 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas:*

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor

shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

6.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

F. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. *Shop Drawings:*

    a. Submit number of copies specified in the General Requirements.

    b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples:*

    a. Submit number of Samples specified in the Specifications.

    b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Submittal Procedures:*

1. Before submitting each Shop Drawing or Sample, Contractor shall have:

    a. reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

    b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

    c. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

    d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop

Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review:*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures:*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 *Continuing the Work*

A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on representation of Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;

6. any inspection, test, or approval by others; or

7. any correction of defective Work by Owner.

6.20 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable .

B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor,

Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

A. Owner may perform other work related to the Project at the Site with Owner's employees, or through other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to Contractor prior to starting any such other work; and

2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.

C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;

2. the specific matters to be covered by such authority and responsibility will be itemized; and

3. the extent of such authority and responsibilities will be provided.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 *Legal Relationships*

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's wrongful actions or inactions.

C. Contractor shall be liable to Owner and any other contractor under direct contract to Owner for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's wrongful action or inactions.

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

8.02 *Replacement of Engineer*

A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

A. Owner's duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

8.06 *Insurance*

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 *Change Orders*

A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents.

8.12 *Compliance with Safety Program*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents.

9.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits

and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.06 *Shop Drawings, Change Orders and Payments*

A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.

D. In connection with Engineer's authority as to Applications for Payment, see Article 14.

9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question.

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

9.10 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Engineer has been informed pursuant to Paragraph 6.13.D.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.D.

10.03 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 *Claims*

A. *Engineer's Decision Required*: All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

B. *Notice:* Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The

opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).

C. *Engineer's Action*: Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

1. deny the Claim in whole or in part;

2. approve the Claim; or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 *Cost of the Work*

A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on

Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

    a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

    b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

    c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

    d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

    e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, express and courier services, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

B. *Costs Excluded:* The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A.

C. *Contractor's Fee:* When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

D. *Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

11.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances:*

1. Contractor agrees that:

a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. *Contingency Allowance:*

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

2. there is no corresponding adjustment with respect to any other item of Work; and

3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;

b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the

control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 *Notice of Defects*

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

13.03 *Tests and Inspections*

A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;

2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.

E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. repair such defective land or areas; or

2. correct such defective Work; or

3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute

resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and for the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct, or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and

equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 *Progress Payments*

A. *Applications for Payments:*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the

Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. *Review of Applications:*

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

   a. the Work has progressed to the point indicated;

   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and any other qualifications stated in the recommendation); and

   c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or

   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

   a. to supervise, direct, or control the Work, or

b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or

e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

   a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

   b. the Contract Price has been reduced by Change Orders;

   c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

   d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. *Payment Becomes Due:*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. *Reduction in Payment:*

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

   a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;

   b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

   c. there are other items entitling Owner to a set-off against the amount recommended; or

d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1 and subject to interest as provided in the Agreement.

14.03 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the tentative certificate to Owner, notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will, within said 14 days, execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities

pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the tentative list.

14.05 *Partial Utilization*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 14.04.A through D for that part of the Work.

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 *Final Payment*

A. *Application for Payment:*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

   a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.6;

   b. consent of the surety, if any, to final payment;

   c. a list of all Claims against Owner that Contractor believes are unsettled; and

   d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. *Engineer's Review of Application and Acceptance:*

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Payment Becomes Due:*

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor's repeated disregard of the authority of Engineer; or

4. Contractor's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:

1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion);

2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere; and

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B and 15.02.C.

15.03 *Owner May Terminate For Convenience*

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.

B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions; or

2. agrees with the other party to submit the Claim to another dispute resolution process; or

3. gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended; or

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

17.06 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

SECTION 00 7300

SUPPLEMENTARY CONDITIONS

PART 1 GENERAL

1.1 GENERAL

A. These Supplementary Conditions shall modify and supplement the Standard General Conditions of the Construct Contract (Section 00 7215 - EJCDC C-700 2007 Edition), and shall govern whenever they conflict. All provisions which are not so amended or supplemented remain in full force and effect. The Standard General Conditions of the Construction Contract are reproduced herein with no changes.

1.2 MODIFICATIONS TO ARTICLES OF THE GENERAL CONDITIONS

A. ARTICLE 1 – DEFINITIONS

1. Paragraph 1.01.A.19 is supplemented with the following: Where the term "Engineer" is used in the Specification for the approval of materials or work, it shall be understood to mean AECOM.

2. Paragraph 1.01.A.29 is supplemented with the following: Whenever the term "Owner" is used in the Contract Documents, it shall refer to the Warren County Board of Commissioners, or its authorized representative.

B. ARTICLE 2 – PRELIMINARY MATTERS

1. Paragraph 2.02 – Copies of Documents, will be as stated in Division 01 Section "Summary of Work".

2. Paragraph 2.03 – Commencement of Contract Time: Notice to Proceed is amended as follows:
Delete the last sentence.

C. ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

1. Paragraph 3.03.A.1 – Add the following after the last sentence:

"By executing the contract, the Contractor also represents and affirms that the Contractor is familiar with federal, state, and local laws, ordinances, rules and regulations that may in any manner affect cost, progress, or performance of the work."

2. Paragraph 3.03.B.1.c – Add the following paragraphs:
"c. If any portion of the Contract Documents conflicts with any other portion, the various documents comprising the Contract Documents govern in the following order of precedence: the Agreement; Supplementary Conditions (including Division 1 documents): these General Conditions; the Specifications; and the Drawings. As between detailed drawings and general drawings, the detailed drawings govern. As between noted materials and graphic indications of materials, the noted materials govern.

d. Should the Contract Documents disagree as to quality or quantity of work required, the Contractor must provide the better quality or greater quantity unless the Owner gives written instructions to the contrary.

e. Where the drawings show only a portion of the work in full detail and the remainder is shown only in outline, the Contractor must execute the portions in outline as required for like portions shown in full detail. Where items are shown in diagrammatic/schematic drawings, the Contractor must verify location with the Construction Manager or as instructed by the Construction Manager before installation."

3. Paragraph 3.04.A – Replace with the following:
"A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work which affect the price of the work or contract times, or to modify the terms and conditions thereof, by either a written Change Order or a written Work Change Directive signed by the Owner or its authorized representative(s)."

D. ARTICLE 4 – AVAILABILITY OF LANDS: PHYSICAL CONDITIONS: REFERENCE POINTS

1. Paragraph 4.01.B – Delete paragraph in its entirety and insert the following:

"B. Upon reasonable request, Owner shall furnish Contractor with a current Notice of Commencement."

2. Paragraph 4.02 – Subsurface and Physical Conditions is supplemented with: In the preparation of Drawings and Specifications the ENGINEER has relied upon those indicated in Division 00 Section "Geotechnical Data".

3. Paragraph 4.03.A.4 – Delete paragraph in its entirety and insert the following in its place:
"4. …is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

Then Contractor shall, promptly after becoming aware thereof and in no event later than seventy-two (72) hours after first discovering that condition, and before further disturbing the subsurface or physical conditions or performing any work in connection therewith (except in an emergency as required by paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any work in connection therewith (except as aforesaid) until receipt of written order to do so. In the event the condition is continuing, Contractor shall send additional or subsequent notices at intervals of not less than twenty-one (21) consecutive days until the condition ceases or abates. Failure to provide such notices or avoid further disturbance shall constitute a waiver by Contractor of his right to seek adjustment of the contract times or contract price as a result of such condition."

4. Paragraph 4.03.C.1.c – Add the following paragraph:
"c. Contractor has provided written notice to the Owner of the condition as required by Paragraph 4.03.A.4."

5. Paragraph 4.03.C.1.d – Add the following paragraph:

"d. Engineer recommends to the Owner that the requested adjustment to the contract price or contract times is equitable."

6. Paragraph 4.03.C.3 – Add the following language at the end of this paragraph: "In the event a claim is filed, the Contractor will not be relieved of the obligation to continue work during the resolution of the claim."

7. Paragraph 4.05.A – Add the following paragraph to the end:
"The Contractor shall notify the Owner forty-eight (48) hours in advance for the establishment of the base lines, benchmarks, or layout work.

8. Paragraph 4.06 – Add the following subparagraph 4.06.A.1:
   1. Delete Paragraphs 4.06.A and 4.06.B in their entirety and insert the following:
      a. No reports or Drawings related to hazardous Environmental Conditions at site are know to the Owner.
      b. Not used.

9. Paragraph 4.06.G – Delete paragraph in its entirety.

E. ARTICLE 5 – BONDS AND INSURANCE

1. Paragraph 5.01.A – Amend the second sentence to read: "…These bonds shall remain in effect not less than one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents…"

2. Paragraph 5.01.C – At the end of this paragraph, add the following: "…and both of which shall provide coverage security for the interim during which the bond has lapsed."

3. Paragraph 5.01.D – Add the following paragraph:
"D. If the Contractor provided a certified or cashier's check or letter of credit as Bid Security, he shall furnish a Performance Bond in an amount at least equal to 100% of the Contract Price as security for the faithful performance of this agreement."

4. Paragraph 5.01.F – Add the following paragraph:
"F. Each of the Bonds shall be on the forms attached to the Contract Documents, or substantially equivalent forms, and shall have a Surety thereon. Such Surety company or companies as are approved by the Owner and in accordance with Paragraph 5.01. Each of the Bonds shall be submitted in accordance with Paragraph 2.01."

5. Paragraph 5.02.B and 5.02.C – Add the following paragraphs following 5.02.A:
"B. All insurance must be placed with companies with an AM Best's rating of at least: A-VII and be acceptable to Owner; Owner's acceptance will not be unreasonably withheld.

C. All surety and bonds provided must be executed by a surety or surety's license to conduct business in the State of Ohio and named in the current list of "Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Insurance Companies" as published in Circular 570 (amended) by the

Audit Staff Bureau of Accounts, U.S. Treasury Department."

6. Paragraph 5.04.C – Add the following new paragraph immediately after 5.04.B:

"C. The Contractor shall, at his own expense, purchase and maintain the following minimum coverage:

1. Workers Compensation, for claims for bodily injury, sickness, disease or death as follows:
   a. Coverage A Statutory Benefits as described by the applicable law.
   b. Coverage B Employer's Liability:

      $500,000 Bodily Injury by Accident - each employee
      $500,000 Bodily Injury by disease - each employee
      $500,000 Bodily Injury by disease - policy limit

      For Ohio projects, the Contractor shall provide a copy of a certificate of premium payment from the Industrial Commission and Bureau of Workers Compensation, State of Ohio, for the period of time specified during which construction commences and copies of renewal certificates for subsequent periods, so long as the project continues. For work outside the State of Ohio, a Workers Compensation and Employer's Liability policy shall be certified. In this instance, a 60-day notice of cancellation or material change shall be provided to the Owner and Engineer.
2. Comprehensive General Liability Coverage for Bodily Injury and Property Damage - occurrence form.

General Aggregate	$2,000,000	Each occurrence, combined single limit for Bodily Injury and Property Damage
Products – Completed Operations	$1,000,000	Each occurrence
Aggregate	$2,000,000	
Personal and Advertising Liability per Occurrence	$1,000,000	Combined Single Limit for Bodily Injury and Property Damage

Coverage shall be extended to include the following:

a. Per project and per location aggregate.
b. Premises and operations coverage.
c. Coverage for liability of independent contractors.
d. Products and completed operations.
e. Coverage for explosion, collapse and underground hazards.
f. Stop-Gap Liability: All monopolistic states - $1,000,000.
g. Owner and Engineer as additional insureds (alternative: Furnish separate hi. Owner's protective liability including Engineer as a named Insured. Owner and Engineer to be additional insureds under Products and Completed Operation Coverage of Contractor).
h. Waiver of Subrogation against Owner and Engineer.
i. 60-Day Notice of Cancellation or material change.

3. Comprehensive Automobile Liability Insurance - Occurrence Form

Any Automobile	$1,000,000	Bodily Injury and Property Damage, Combined Single Limit
Borrowed, Non-Owned	$1,000,000	Bodily Injury and & Hired Automobile Property Damage, Combined Single Limit

Coverage shall be extended to include:

a. Contractual liability for assumed liability.
b. Owner and Engineer as additional insureds.
c. Waiver of Subrogation against Owner and Engineer.
d. 60 Day Notice of Cancellation or material change.
e. Motor Carrier Act Endorsement MCS-90 (where applicable).
f. Extra Wide/Extra Heavy Hauling Permit Endorsement where applicable.

4. An Umbrella Liability or Excess Liability Policy over primary comprehensive General and Automobile Liability shall be carried in a minimum amount of:

$5,000,000 Each Occurrence
$5,000,000 Aggregate

The Umbrella or Excess Policy shall be following form of:

a. Any Additional Insureds under primary policy.
b. Per project and per location aggregates.
c. Explosion, Collapse or Underground Hazards.
d. Stop-Gap Liability.
e. Waiver of Subrogation against Owner and Engineer.
f. Watercraft (when employed to perform the work).
g. Aircraft (when employed to perform the work).
h. 60-Day Notice of Cancellation or material change shall be given to Owner and Engineer.

7. Paragraph 5.06 – Change to provide that the Contractor shall obtain this policy.

8. Paragraph 5.06 – Add new paragraph 5.06.A.8 as follows:
"8. The maintenance of specified insurance coverage is a material element of the contract and failure to maintain or renew insurance coverage or provide evidence of renewal may be treated as a material breach of the contract."

9. Paragraph 5.06 – Add new paragraph 5.06.A.9 and 10 as follows:
"9. The policies of insurance required to be purchased and maintained by Contractor in accordance with Paragraph 5.06.A shall comply with the requirements of Paragraph 5.06.C."

10. Paragraph 5.06 – Add new paragraph 5.06.A.10 as follows:
"10. The Contractor shall obtain the appropriate amount of flood insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit. The Contractor shall take into consideration the proximity of their work to rivers, drainage swales, work on or

in proximity to storm sewer systems, unstable soils, work schedule, climate, the Contractor's means and methods, and any other considerations."

11. Paragraph 5.06.B – Delete and replace with the following:
"B. Contractor shall be responsible for any deductible or self-insured retention, and shall have those limits approved by Owner, which approval shall not be unreasonably withheld."

12. Paragraph 5.11 – Add new Article 5.11 as follows:
"5.11 *Adequacy of Climate*
The Owner and Engineer, as well as their officers and employees, assume no responsibility for the adequacy of limits and coverages in the event of any claim(s) against the Contractor, its officers, employees, subcontractors, or any sub-subcontractor or agent of any of them. The types, forms, and amounts of insurance specified should be considered minimal, and in no way does the Owner or Engineer imply expressly or otherwise that the coverages specified will cover all exposures to loss and are in amounts sufficient to assure the Contractor, any subcontractor, or sub-subcontractor that uncovered losses will not occur or insurance limits will be adequate. The contractors should seek outside insurance counsel to determine adequate insurance protection for their particular operations. Meeting the insurance specifications shall in no way relieve any contractor, subcontractor or sub-subcontractor of any obligations under the contract, and any indemnification obligations shall survive the exhaustion of insurance limits carried, and shall be fully enforceable to the extent allowed by governing law, regardless of whether loss or losses are not covered by insurance. All insurance purchased by the Contractor for this work shall be 'primary' and 'non-contributory'."

F. ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

1. Paragraph 6.01.A – After the first sentence add: "Contractor's Work shall be performed according to the standard of care normally exercised by construction organizations within Ohio that are engaged in performing comparable services devoting such attention thereto and applying such skills as may be necessary to perform the work in accordance with the Contract Documents."

2. Paragraph 6.02.C – Add a new paragraph as following:

"C. If the Contractor does not perform the work in accordance with the Contractor's construction schedule and the project construction schedule, and it becomes apparent that the work may not be completed within the contract times, the Contractor shall, at no additional cost to the Owner or the Engineer, as necessary to improve the Contractor's progress: (a) increase the number of employees in such crafts as will regain lost scheduled progress; and (b) increase the number of working hours per shift, shifts per working day, working days per week, the amount of equipment, or any combination of the foregoing measures to regain lost scheduled progress. Contractor shall furnish such employees, materials, facilities, and equipment, and shall work such hours, including extra shifts, overtime operations, and Sundays and holidays, as may be necessary to insure the prosecution and completion of the work in accordance with the Contractor's construction schedule and the project construction schedule.

3. Paragraph 6.02.D – Add a new paragraph as follows:

"D. Contractor shall at all times maintain good discipline and order at the site. The Contractor shall not permit employment of unfit persons or persons not skilled in tasks assigned to them. If the Owner or Engineer deems any employee of the Contractor or a subcontractor unsatisfactory, the Contractor must transfer or require its subcontractor to transfer such employee from the project immediately."

4. Paragraph 6.04.A.3 – Add a new paragraph as following:

"3. In addition, the Owner may require the Contractor to prepare and submit a recovery schedule demonstrating the Contractor's program and proposed plan to regain lost schedule progress and to insure completion of the work within the contract times. If the Owner finds the proposed plan not acceptable, the contractor may be required to submit a new plan. If the actions taken by the Contractor or the Contractor's second proposed plan are not satisfactory, the Owner may require the Contractor to take any of the actions set forth in paragraph 6.02.C at no additional cost to the Owner."

5. Paragraph 6.06.B – Add the following sentence to the end of paragraph 6.06.B.: "If requested by Owner, Contractor must furnish names of Subcontractor, Suppliers, or other persons or organizations within five days after Bid opening. See Instruction to Bidders, ARTICLE 12 for additional information."

6. Add Paragraph 6.06.H as follows:

"H. The CONTRACTOR shall furnish to the OWNER and the ENGINEER, in writing, a copy of the Notice of Furnishings for each of the Subcontractors proposed for each portion of the work, prior to commencement of work on the respective subcontract."

7. Add Paragraph 6.06.I as follows:

"I. OWNER or ENGINEER may furnish to any such Subcontractor, Supplier, or other person or organization, to the extent practicable, information about amounts paid to CONTRACTOR in accordance with CONTRACTOR'S Applications for Payment on account of the particular Subcontractor's, Supplier's, or other person's or other organization's work."

8. Paragraph 6.07.B – Delete paragraph in its entirety.

9. Paragraph 6.08 – Replace this paragraph with the following:
"A. The OWNER has or will obtain the following permits:

OHIO EPA DDAGW PLAN APPROVAL
OHIO EPA PTI
WARREN COUNTY BUILDING PERMIT

The CONTRACTOR shall secure and pay for all other permits necessary to complete the construction."

10. Paragraph 6.10 - Taxes, is amended as follows:
"A. OWNER, being a public body, is exempt from taxes on material incorporated in the work. CONTRACTOR, therefore, is not required to pay such materials taxes. The OWNER will provide the tax exemption forms. These forms are to contain all necessary information required by the State.

The CONTRACTOR shall complete all applicable information and submit to OWNER for signature. The CONTRACTOR may submit an additional form with the SUB-CONTRACTOR portion blank, which may be reproduced at later dates for various SUB-CONTRACTORS.

B. Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.

C. Contractor is specifically required to abide by all local tax requirements, if any, including income tax requirements to withhold at source. Contractor acknowledges that the Contract work may take place in more than one county and more than one city, and further acknowledges different tax burdens may be imposed in each. Contractor shall indemnify, defend, and hold Owner harmless from any federal, state, or local tax liabilities incurred as a result of Contractor performing the Work."

11. Paragraph 6.11.A.3 – Replace with the following paragraph:
"3. To the fullest extend permitted by law, the Contractor shall indemnify, defend, and hold harmless the Owner and Engineer and the consultants, professionals, agents, and employees of any of them from and against any and all claims, damages, loss and expenses, and all court costs or costs or arbitration or other dispute resolution costs, including but not limited to attorney's fees incurred through such indemnified party's attorney of choice, arising out of or resulting from the performance of the work but only to the extent caused in whole or in part by negligent acts or omissions of the Contractor, a subcontractor (regardless of tier), any one directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss or expenses was caused in part by a party indemnified hereunder. Such obligations shall not be construed to negate, abridge or reduce other rights or obligations of indemnity which would otherwise exist as to a party or persons described in this Paragraph 6.11.A.3. The Contractor shall promptly and contemporaneously reimburse the Owner, Engineer, and their respective successors and assigns for any cost, expense or attorneys' fees incurred on account of any such suit or claim where incurred in enforcing the terms of the contract. The Contractor shall cause

this indemnification provision to be included in every subcontract, regardless of tier, entered into with regard to the work."

12. Paragraph 6.11.E – Add the following paragraph:
"E. The Contractor shall construct and maintain all necessary temporary drainage and do all pumping necessary to keep all excavations, floors, pits, and trenches relating to the work free from water. Unless specifically assigned to another, the Contractor shall at all times provide protection for its work from rain, wind, storms, frost, or heat, so as to maintain all work, materials, apparatus, and fixtures free from injury and damage. At the end of each day's work, the Contractor shall cover and/or protect to the extent possible all work likely to be damaged. If low temperatures make it impossible to continue operations in spite of cold-weather precautions, the Contractor shall cease operation and notify the Owner and Engineer in writing."

13. Paragraphs 6.13 and 6.14 - Safety and Protection, are supplemented with the following: "All construction work under this Agreement is subject to Chapter XVII of Title 29, Code of Federal Regulations (CFR) Part 1926 (formerly Chapter XIII of Title 29, CFR, Part 1518) titled, "Safety and Health Regulations for Construction" and subsequent amendments."

14. Paragraph 6.17 - Shop Drawings and Samples – Delete this paragraph entirely.

15. Paragraph 6.19.A – Replace with the following paragraph:
"A. Contractor warrants and guarantees to Owner that all work will be performed in accordance with the Contract Documents, will be performed in a workmanlike manner, and will not be defective. In addition, the Contractor warrants to the Owner and Engineer that the Contractor and its subcontractors (regardless of tier) will exercise in the performance of the work the standard of care normally exercised by construction organizations within Ohio, which are engaged in performing comparable services."

16. Paragraph 6.19.D – Add the following paragraph:
"D. Upon final payment, the Contractor must assign and transfer to Owner all guarantees, warranties and agreements from and with all contractors, subcontractors, vendors, suppliers, and manufacturers regarding their performance, quality of workmanship, or quality of materials supplied in connection with the work. Contractor represents and warrants that all such guarantees, warranties, and agreements will be in place and enforceable by the Owner in accordance with their terms. The Owner, however, will not assume through any assignment or transfer required under this subparagraph any of the Contractor's payment obligations to any entities."

17. Paragraph 6.20.A – Delete entire paragraph and replace with the following:
"A. To the fullest extent permitted by law, the Contractor shall indemnify, defend, and hold harmless the Owner and Engineer and the consultants, professionals, agents, and employees of any of them from and against any and all claims, damages, loss and expenses, and all court costs or costs of arbitration or other dispute resolution costs, including but not limited to attorneys' fees incurred through such indemnified party's attorney of choice, arising out of or resulting in whole or in part from the performance of the work but only to the extent caused in whole or in part by negligent acts or omissions of the Contractor, a

subcontractor (regardless of tier), anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expenses caused in part by a party indemnified hereunder. Such obligations shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity which would otherwise exist as to a party or persons described in this Paragraph 6.20.A. The Contractor shall promptly and contemporaneously reimburse the Owner, Engineer, and their respective successors and assigns for any cost, expense or attorneys' fees incurred on account of any such suit or claim where incurred in enforcing the terms of the contract. The Contractor shall cause this indemnification provision to be included in every subcontract, regardless of tier, entered into with regard to the work."

G. ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

1. Paragraph 9.01.A – Replace the first sentence with the following:
   "A. Engineer will be the Owner's representative during the construction period to the extent outlined in this Article 9 and subject to the limits set forth therein and in the contract documents."

2. Paragraph 9.03.B – Add a new paragraph as follows:
   "B. The responsibilities and authority and limitation thereon of the Resident Project Representative will be as provided in these Supplementary Conditions:
      1. Conduct on site observations of the Work in progress to assist ENGINEER in determining if the Work is in general proceeding in accordance with the Contract Documents.
      2. Report to ENGINEER whenever any Work will not produce a completed Project that conforms generally to the Contract Documents or will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements on any inspection, test or approval required to be made; and advise ENGINEER of Work that should be corrected, rejected or should be uncovered for observation, or requires special testing, inspection or approval.
      3. Verify that tests, equipment and systems start-ups and operating and maintenance training are conducted in the presence of the appropriate personnel, and that CONTRACTOR maintains adequate records thereof; and observe, record and report to ENGINEER appropriate details relative to the test procedures and start-ups.
      4. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Project, record the results of these inspections and report to ENGINEER.
      5. Report to ENGINEER when clarifications and interpretations of the Contract Documents are needed and transmit to CONTRACTOR clarifications and interpretations as issued by ENGINEER.
      6. Consider and evaluate CONTRACTOR's suggestions for modifications in Drawings or Specifications and report recommendations to ENGINEER.
      7. Limitations of authority by Resident Project Representative:
         a) Shall not authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items), unless authorized by ENGINEER.

b) Shall not exceed limitations of ENGINEER's authority as set forth in the General Conditions or Contract Documents.
c) Shall not undertake any of the responsibilities of CONTRACTOR, Subcontractor, Suppliers, or CONTRACTOR's superintendent.
d) Shall not advise on, issue directions relative to or assume control over any aspect of the means, methods, techniques, sequences or procedures of construction unless such advise or directions are specifically required by the Contract Documents.
e) Shall not advise on, issue directions regarding or assume control over safety precautions and programs in connection with the Work.
f) Shall not accept Shop Drawings or Sample submittals from anyone other than CONTRACTOR.
g) Shall not authorize OWNER to occupy the Project in whole or in part.
h) Shall not participate in specialized field or laboratory tests or inspections conducted by others except as specifically authorized by ENGINEER."

3. Paragraph 9.09.F – Add the following paragraph:
"F. Under no circumstances is Engineer or resident project representative authorized to approve on behalf of Owner variations in the work which result in adjustments to the contract times or contract price. Contractor may not rely upon any verbal communication from any party as to the authorization to perform work which may give rise to adjustments in contract times or contract price."

H. ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

1. Paragraph 10.03.A.4 – Add the following paragraph:
"4. In no event is the Contractor entitled to reserve any rights or take other similar action with respect to a change order if the effect or intent of such reservation or action would be to accommodate a further adjustment in the contract times, contract price, or both, after the Contractor executes the change order. By executing a change order, the Contractor irrevocably certifies that the elements of the change order described are completely satisfied and waives all rights to seek further adjustment of the contract times, contract price, or both, at a later date with respect to the associated change in the work."

2. Paragraph 10.05.G – Add the following:
"Owner makes no representations with regard to subsurface conditions or site availability other than those set forth in the Contract Documents. Contractor acknowledges and agrees he will make no claim against Owner which would affect additional contract price in the event that actual subsurface conditions do not conform to those indicated by the Contract Documents or other subsurface investigations conducted by Contractor. Contractor assumes the risk of the assumptions made with regard to subsurface conditions in formulating the bid. Contractor's sole remedy in such an event shall be an increase in contract times which may be granted by Engineer and Owner should Contractor make a claim therefore as required by General Conditions 10.05."

I. ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

1. Paragraph 11.01.A.5.c – Add the following sentence to the end of the paragraph: "Equipment or machinery with a value of less than $1,000 will be considered small tools."

2. Replace Paragraph 11.03.D.1 with the following:
"If the quantities in the Contract documents are changed by more than 25% in a proposed Change Order such that application of the agreed unit prices to the quantities of work proposed causes substantial inequity to the owner or the Contractor, the applicable unit prices may be negotiated and equitably adjusted for those quantities in excess of 25%."

J. ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

1. Paragraph 12.01.A – The first sentence of Paragraph 12.01.A should be replaced in its entirety with the following: "The contract price may only be changed by a written change order signed by the Contractor and the Owner or its authorized representative(s)."

2. Paragraph 12.01.B – Replace the paragraph to read as follows: "B. The value of any Work covered by a Change Order, any claim for an increase or decrease in the Contract Price, or any claim for damages shall be determined as follows:…"

3. Paragraph 12.01.C.2.e – Add the following at the end of paragraph GC-12.01.C.2.e: "Any change that results in a net decrease in cost shall include the appropriate overhead and profit added thereto calculated as set forth in ARTICLE 12 of the General Conditions."

4. Paragraph 12.01.D – Insert new paragraph as follows: "D. In no event shall Contractor be entitled to any increase in the Contract Price on account of any adverse weather."

5. Paragraph 12.02.A – The first sentence of Paragraph 12.02.A should be replaced with the following: "The contract times may only be changed by a written change order signed by the Contractor and the Owner or its authorized representative(s)."

6. Paragraph 12.02.B – Replace Paragraph 12.02.B with the following language:
"B. If the Contractor wishes to make a claim for an increase in the contract times, prompt written notice as provided herein shall be given. The Contractor's claim shall include an estimate of cost and of probable effect of delay on progress of the work, a detailed schedule which identifies the critical portions of the work impacted by the delaying event and the dates of such impact, and a statement from Contractor that the increase requested is the entire increase in the contract time associated with the claim. The failure to provide such information and statement within the time period established in Paragraph 10.05.B shall constitute an irrevocable waiver of the claim. In the case of a continuing delay occurring on consecutive days, only one claim is necessary, provided, however, that within ten (10) days of the cessation of the cause of the continuing delay, the Contractor shall notify the construction manager in writing that the cause of the delay has ceased. The failure to give notice of the cessation of the cause of the continuing delay shall constitute an irrevocable waiver of any claim based upon the continuing delay."

7. Add the following paragraph as Paragraph 12.02.C:
"In addition to the requirements of Paragraph 12.02.B, if adverse weather conditions are the basis for a claim for additional time, the contractor shall support such claim with data acceptable to the Owner and Engineer that substantiates that weather conditions were significantly abnormal for the period of time and could not have reasonably been anticipated and that weather conditions had an adverse effect on a critical element of the scheduled construction. Notwithstanding any other provision of the Contract Documents to the contrary, the project times will not be adjusted on account of the impact of any normal adverse weather or any of the work or on account of the impact of any abnormal

adverse weather on non-critical elements of the work. The support for and evaluation of all adverse-weather claims resulting in lost work days shall be based upon criteria as provided for in the State of Ohio Department of Transportation (ODOT) Construction and Material Specifications dated January 1, 2013. ODOT Specification 108.06.C lists the number of days that the Contractor may expect to be lost due to the weather as follows:

Month	Number of Days Lost Due to Weather
January	8
February	8
March	7
April	6
May	5
June	5
July	4
August	4
Spetember	5
October	6
November	6
December	6

8. Paragraph 12.03.F – Add new paragraph as follows:
"F. Any proposed time extensions for delays requested because of abnormal weather conditions shall be subject to Paragraph 12.02.C."

K. ARTICLE 14 – PAYMENT TO CONTRACTOR AND COMPLETION

1. Paragraph 14.02.A.2 – Replace in its entirety with the following:
"2. Beginning with the second application for payment, each application shall include a notarized affidavit of contractor stating that all previous progress payments received on account of the work have been applied to discharge Contractor's legitimate obligations associated with the prior applications for payment. In addition to any other information that the Owner or Engineer may require, the Contractor's notarized application for payment package shall include: (1) a partial conditional lien waiver from the Contractor for the total payment requested in the application for payment; (2) a partial conditional lien waiver from all subcontractors (regardless of tier) and material and equipment suppliers on those account the Contractor is seeking payment in the application for payment for the total amount of such payment requested; (3) a partial unconditional lien waiver from the Contractor for the sum of all previous paid progress payments. Preliminary copy of the Application for Payment shall have quantities reviewed and agreed by the Engineer's Resident Project Representative, if on site."

2. Add new Paragraph to 14.02.A.4 as follows:
"4. Each progress payment shall be accompanied by an approved and updated schedule or acceptable recovery schedule or progress payment shall be rejected."

3. Add new Paragraph 14.02.A.5 as follows:

"5. Partial Payment

Partial payments to the CONTRACTOR for labor performed and materials delivered to the site or incorporated into the Project under either a unit or lump sum price contract shall be made at the rate of 92 percent of the estimates as prepared by the CONTRACTOR and approved by the ENGINEER until the work under this Contract is determined by the ENGINEER to be 50 percent complete.

Labor performed and material incorporated into the Project after the work under this Contract is approved as 50 percent complete, will be paid for on the basis of 100 percent of the estimates as prepared by the CONTRACTOR and approved by the ENGINEER.

A Contract shall be considered 50 percent complete when the CONTRACTOR has been paid an amount equal to 50 percent of the total cost of the labor of the Contract and 50 percent of the total cost of the material of the Contract.

All material furnished and delivered but not actually included in the construction and approved by the ENGINEER, after the work under this Contract is 50 percent complete, shall be paid for at the rate of 92 percent of the invoiced value of the materials. The balance of such estimates shall be paid when the material is incorporated into and becomes a part of the building construction.

4. Paragraph 14.02.A.6 – Add new paragraph as follows:

6. Final Estimate

A final estimate shall be made as soon as practicable after completion of the work under this Contract and final approval by the ENGINEER and acceptance by the OWNER, in writing. After such approval, the CONTRACTOR will be paid such portion of the remaining Contract Price as is necessary to bring the aggregate partial payments received to 96 percent of this Final Estimate. The final estimate shall be based on a total costs including all change orders.

5. Paragraph 14.02.A.7 – Add new paragraph as follows:

7. Retention

After the Contract is 50 percent complete all retained funds will be placed in an escrow account and the OWNER agrees to pay the CONTRACTOR the accumulated interest thereon upon release of the retainage, less expenses incurred in the establishment and maintenance of that escrow account by the Owner.

Upon acceptance of Substantial Completion, the amount retained will be reduced to 4%. The 4% balance shall be retained for 30 days after completion and final approval by the OWNER in writing.

If at any time prior to Final Payment the Contractor is found to be in violation of Paragraph 14.02 of the General Conditions, the Owner will retain 10% of the amount of all Progress Payments."

6. Paragraph 14.02.B.6, add new paragraph as follows:

"6. Engineer may also refuse to recommend a minimum of 25% up to a maximum of 100% of any payment if any of the following occur:

a. Third party claims filed or reasonable evidence indicating probable filing of such claims.
b. Failure of the Contractor to make payments properly to Subcontractors or for labor, materials, or equipment. Reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum.
c. Damage to the Owner or another Contractor.
d. Reasonable evidence that the Work will not be completed within the. Contract Time.
e. Persistent failure to carry out the Work in accordance with the Contract Documents.
f. Failure to maintain updating of "As-Built Drawings.
g. Failure to properly coordinate with other Contractors.
h. O&M Manual not submitted to the Engineer when equipment is delivered to job site."

7. Paragraph 14.02.D.4 – Insert the following paragraphs immediately following paragraph 14.02.D.3:

"4. Notwithstanding any other provision of the contract documents to the contrary, if Contractor disputes any determination by the Owner or Engineer with regard to an application for payment or a certificate for payment, the Contractor must nevertheless continue to prosecute the work expeditiously.

5. The Contractor shall keep the funds encumbered for the work free and clear of all claims as defined under Ohio Revised Code Section 1311.25, et seq ., which claims are also referred to throughout the Contract Documents as liens. Notwithstanding any other provision of the Contract Documents to the contrary, if any such claim is filed or asserted, or where there is any reason to believe that any such claim may be filed or asserted at any time, the Owner may refuse to make any payment otherwise due to the Contractor or withhold from any payment due the Contractor a sum sufficient, in the opinion of the Owner or as required by law, to pay all obligations and expenses necessary to satisfy such claim and to indemnify the Owner against any such claim and until the Contractor furnishes satisfactory evidence that the indebtedness and the claim in respect thereof, if any, has been satisfied, discharged, and released of record, if any, as provided by law pending the resolution of any dispute between the Contractor and the entity filing such claim. If such evidence is not furnished by the Contractor to the Owner within a period of seven (7) days after demand therefore, the Owner may discharge such indebtedness as provided by law and deduct the amount required therefore together with any and all losses, costs, damages and attorneys' fee (incurred through an attorney of the Owner's choosing) suffered or incurred by the Owner from any sum payable to the Contractor. If payments then and thereafter due to the Contractor are not sufficient to cover such amount, the Contractor shall immediately pay the difference to the Owner. Final payment to the Contractor may be withheld until the work and any funds encumbered therefore are free and clear of any and all claims or rights thereto arising because of the work performed or materials furnished under the Contract Documents."

8. Paragraph 14.04.F – add new paragraph as follows:
   "F. The Owner and the Engineer shall have the option to correct or conclude any and all Construction Punch List items not completed by the Contractor within the time specified in the Substantial Completion Certificate by utilizing its own forces or by hiring others, pursuant to Termination of the Contract under Article 15. The cost of such correction of remaining Construction Punch List items by the Owner or others shall be deducted from remaining monies due the Contractor. If the Contractor does not complete certain Construction Punch List items within specified time periods, all warranties and guarantees related to such incomplete Construction Punch List items shall not begin to elapse until issuance of Final Payment for the work.."

9. Paragraph 14.05 – Add the following new paragraph immediately after 14.05.A.1:
   "2. Owner may at any time request Contractor in writing to permit Owner to take over operation of any such part of the Work although it is not substantially complete. A copy of such request will be sent to Engineer and within a reasonable time thereafter Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion and will prepare a list of the items remaining to be completed or corrected thereon before final payment. If Contractor does not object in writing to Owner and Engineer that such part of the Work is not ready for separate operation by Owner, Engineer will finalize the list of items to be completed or corrected and will deliver such lists to Owner and Contractor together with a written recommendation as to the division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, maintenance, utilities, insurance, warranties, and guarantees for that part of the Work, which will become binding upon Owner and Contractor at the time when Owner takes over such operation (unless they shall have otherwise agreed in writing and so informed Engineer). During such operation and prior to Substantial Completion of such part of the Work, Owner shall allow Contractor reasonable access to complete or correct items on said list and to complete other related Work."

10. Paragraph 14.05.A.2 shall be renumbered to 14.05.A.3.

11. Paragraph 14.05.A.3 shall be renumbered to 14.05.A.4.

12. Paragraph 14.05.A.4 shall be renumbered to 14.05.A.5.

13. Paragraph 14.07.D – Add this additional paragraph following 14.07.C.1:
    "Not withstanding any provision of the Contract Documents to the contrary, (a) the Owner may make final payment or any part thereof jointly to the Contractor and its subcontractors (regardless of tier) and material and equipment suppliers; and (b) final completion of the work will not occur until:
    1. The work is entirely complete in accordance with the Contract Documents;
    2. The Contractor has fulfilled all of its duties and obligations under the contract (other than warranty and similar obligations that survive final completion);
    3. The Contractor delivers to the Owner a final unconditional lien waiver from the Contractor and each of the Contractor's subcontractors (regardless of tier) and material and equipment suppliers; and
    4. The Contractor has fulfilled all of his project closeout obligations, including, but not limited to, providing all maintenance and operating instructions and manuals, and all

drawings, certificates, bonds, guarantees, and other documents required by the Contract Documents to the construction manager or Owner as appropriate."

14. Paragraph 14.10 – Add new paragraph as follows:
"10. The CONTRACTOR, ENGINEER, and OWNER will execute a final Contract Completion Certificate for the Contract which indicates the date of acceptance. The form will be provided by the ENGINEER upon written notification by the Contractor that the Work is complete."

L. ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

1. Paragraph 15.01.A – Replace the third sentence of Paragraph 15.01.A with the following sentence: "Contractor shall be granted an extension of the Contract Times directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05."

2. Paragraph 15.02.C – Replace the second sentence of Paragraph 15.02.C with the following sentence: "If the unpaid balance of the contract price exceeds all claims, losses and damages (including but not limited to all fees and charges of Engineers, Architects, attorneys, consultants, and other professionals, all as chosen by the Owner, and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing work, such excesses will be paid to Contractor."

3. Paragraph 15.02.G – Add the following new paragraph immediately after Paragraph 15.02.F:
"G. In the event that the Owner's termination for cause pursuant to this paragraph is determined by an arbitrator, arbitration panel or court to have been unjustified, such termination shall be deemed to have been a termination pursuant to Paragraph 15.03."

4. Paragraph 15.02.H – Add the following new paragraph:
"H. Upon termination pursuant to this Paragraph 15.02, the Contractor shall, unless the notice of termination specifically directs otherwise, immediately discontinue the work, place no further orders or subcontracts for materials, equipment, services, or facilities, except as may be necessary for completion of such portion of the work as is not discontinued; promptly make every effort to procure cancellation upon terms satisfactory to the Owner of all orders and subcontracts to the extent that they relate to the performance of a discontinued portion of the work; and thereafter do only such work as may be necessary to preserve and protect the work already in progress and to protect materials and equipment on the Project site or in transit thereto, and deliver such materials and equipment to Owner upon demand."

5. Paragraph 15.02.I – Add the following new paragraph:
"I. When the Owner has terminated the Contractor's services pursuant to this Paragraph 15.02, the termination shall not affect any rights or remedies of the Owner against the Contractor then existing or which may thereafter accrue. Any retention or payment of funds due the Contractor by the Owner shall not release the Contractor from liability for performance of the work in accordance with the requirements of the Contract Documents."

6. Paragraph 15.03.A.1 – Replace with the following:

"1. Completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such work not to exceed fifteen percent (15%) of the cost of the completed and acceptable Work;…"

7. Paragraph 15.03.A.3 – Delete paragraph in its entirety.

8. Paragraph 15.03.C – Add the following new paragraph immediately after paragraph 15.03.B:
"C. If the Owner terminates the contract without cause and for Owner's convenience, and there exists an event of default by the Contractor, the Contractor shall only be entitled to receive such sums as it would be entitled to receive under Paragraph 15.02.
1. Upon receipt of written notice from the Owner of such termination for the Owner's convenience, the Contractor shall:
a. cease operations as directed by the Owner in the notice;
b. take actions necessary, or that the Owner may direct, for the protection and preservation of the work; and
b. except for work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders."

M. ARTICLE 16 – DISPUTE RESOLUTION

1. Paragraph 16.02, Dispute Resolution – Insert the following new paragraph:
"16.02 *Dispute Resolution*:

A. This Contract shall be construed under the laws of the State of Ohio, and the parties hereby stipulate to the venue for any and all claims, disputes, interpretations, litigation of any kind arising out of this Contract being exclusively in the Warren County, Ohio Court of Common Pleas. Unless both parties mutually agree in writing to alternate dispute resolution, disputes shall be resolved with litigation. Further, parties waive any right to bring or remove such matters in or to any other state or federal court."

N. ARTICLE 17 – MISCELLANEOUS

1. Paragraph 17.01.A.1 and A.2 – Replace Paragraphs 17.01.A.1 and A.2 in their entirety with the following:
"1. Delivered in person to the individual referenced in the Agreement, or
2. Delivered or sent by registered or certified mail, postage prepaid, to the persons or individual set forth in the Agreement.
3. If the individual referred in the Agreement is no longer employed with said party, then it shall be delivered to an officer of the Corporation for whom it is intended."

1.3 ADDITIONAL PROVISIONS

A. Access to Places of Manufacture

1. The ENGINEER, OWNER, and their inspectors and agents shall, at all times, have immediate access to all places of manufacture where materials specifically identified for

the projects are being made. The CONTRACTOR shall, whenever so requested, give the ENGINEER access to the proper invoices, bills of lading, etc., and shall provide scales and assistance for weighing or other assistance for measuring and testing any of the materials.

B. Liquidated Damages

1. The CONTRACTOR, and his Surety, acknowledges that time is of the essence in performing the work stipulated in the Agreement. Should CONTRACTOR fail to meet the completion dates set forth in the Agreement, OWNER will suffer added administrative and engineering costs, the necessity of adjusting its start-up program for employing the improvements constructed pursuant to this Agreement along with substantial costly inconveniences, thereby reducing the value to OWNER of this Agreement. Thus, for each day by which CONTRACTOR fails to meet a completion date, CONTRACTOR'S compensation shall be reduced by the following amount of liquidated administrative cost damages per day.

Item	Damages
Substantial Completion	$500.00
Completion of Work	$500.00

In the event that the Substantial Completion date has surpassed the Final Completion date, the liquidated damages shall be cumulative. Owner's identification of the liquidated damage figure does not include a component for fines or administrative penalty from governmental agencies.

2. The CONTRACTOR shall guarantee that he can and will complete the work within the time limit stated in this Contract or within the times as extended as provided elsewhere in this Contract. For the reason that the damage and loss and additional expenses, fees, etc., to the OWNER which will result from the failure of the CONTRACTOR to complete the work within the stipulated time, and will be most difficult or impossible to accurately assess the CONTRACTOR shall be assessed liquidated damages for each calendar day including Saturdays, Sundays, and holidays by which the CONTRACTOR shall fail to complete the work of any part thereof, in accordance with provisions hereof and such liquidated damages shall not be considered as a penalty. The OWNER will deduct and retain out of any money due or to become due hereunder the amount of the liquidated damages, and in case these amounts are less than the amount of liquidated damages, the CONTRACTOR shall be liable for the payment of the difference upon demand of the OWNER.

3. It is agreed that time is of the essence of each and every portion of the work wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where, under the Agreement, an additional time is allowed for completion of any work, the new time limit fixed by such extension shall be of the essence of this Agreement; provided that the CONTRACTOR shall not be charged with liquidated damages or any excess cost when the delay in completion of the work is due:
   a. To any preference, priority or allocation order duly issued by the Government.
   b. To any unforeseeable cause beyond the control and without the fault or negligence of the CONTRACTOR, including, but not restricted to, acts of God or of a public enemy, acts of the OWNER, acts of another CONTRACTOR in the performance of

an Agreement with the OWNER, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and unusually severe weather; and

c. To any delays of Subcontractors or suppliers occasioned by any of the causes specified in sub-sections 1) and 2) of this Article.

4. All claims for an extension of the Contract Time must conform to the requirements of G.C. Article 12. The granting of an extension of the Contract Time is not a requisite to relieving the CONTRACTOR from the assessment of liquidated damages.

C. Archeological Discoveries

1. When the CONTRACTOR'S excavating operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archeological significance, the operations shall be temporarily discontinued. The ENGINEER will contact archeological authorities to determine the disposition thereof. After consultation with the archeological authorities, the ENGINEER may elect to discontinue the work in the area indefinitely, resume normal excavation, or excavate for artifacts. When directed by the ENGINEER to excavate for artifacts, the CONTRACTOR shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper authorities. Such excavation will be considered and paid for as extra work.

D. Chemicals, Substances, and Materials in Contact with Potable Water

1. All chemicals, substances, and materials that come in contact with potable water shall conform to Ohio Administrative Code OAC 3745-83-03 which reads as follows:

"All chemicals, substances, and materials added to or brought in contact with water in or intended to be used in a public water system or used for the purpose of treating, conditioning, altering, or modifying the characteristics of such water shall be shown by either the manufacturer, distributor, or purveyor to be non-toxic and harmless to humans when used in accordance with the formulation and concentration as specified by the manufacturer, and shall conform with the "American National Standards Institute/National Sanitation Foundation" (ANSI/NSF) standard 60 or 61. Any organization certified by the "American National Standards Institute" may certify in writing that a product conforms with these standards.

All chemicals, substances, and materials approved by the Ohio Environmental Protection Agency prior to the effective date of this rule shall retain approval for one year."

2. The two organizations that are currently certified by the "American National Standards Institute" are:
   a. NSF International: Phone (313) 769-8010
   b. Underwriters Laboratories, Inc. Phone (708) 272-8800

E. Chemicals, Substances, and Materials in Contact with Potable Water

1. All chemicals, substances, and materials that come in contact with potable water shall conform to Ohio Administrative Code OAC 3745-83-03 which reads as follows:

"All chemicals, substances, and materials added to or brought in contact with water in or intended to be used in a public water system or used for the purpose of treating, conditioning, altering, or modifying the characteristics of such water shall be shown by

either the manufacturer, distributor, or purveyor to be non-toxic and harmless to humans when used in accordance with the formulation and concentration as specified by the manufacturer, and shall conform with the "American National Standards Institute/National Sanitation Foundation" (ANSI/NSF) standard 60 or 61. Any organization certified by the "American National Standards Institute" may certify in writing that a product conforms with these standards.

2. The two organizations that are currently certified by the "American National Standards Institute" are:
   a. NSF International: Phone (313) 769-8010
   b. Underwriters Laboratories, Inc. Phone (708) 272-8800

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 7300

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SECTION 00 7343

WAGE RATE REQUIREMENTS

PART 1 GENERAL

1.1 REFERENCE

A. Prevailing wage rates, as determined by the United States Department of Labor for Warren County, the county in which the project is located, shall be used in accordance with the provisions of the Davis-Bacon Wage determinations as provided in 29 CFR 1.5 and 1.6(b). A copy of these rates is attached.

1.2 USE

A. Keep posted at all times throughout the Contract period the wage rate pages that are effective at the time of Bid opening.

B. Maintain, throughout the construction period, a legible up-to-date copy. Post in a conspicuous place accessible to workers and protected from the weather.

C. The successful Bidder shall be required to conform to all provisions of the Federal Davis-Bacon and Related Acts (The Act) which requires that all laborers and mechanics employed by contractors and subcontractors performing on federal contracts (and contractors and subcontractors performing on federally assisted contracts under the related ACTS) in excess of $2,000 pay their laborers and mechanics not less than the prevailing wage rates and fringe benefits, as determined by the Secretary of Labor, for corresponding classes of laborers and mechanics employed on similar projects in the area.

D. All Bidders must abide by the latest prevailing wage rate listing effective at the time of Bid opening.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 7343

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"General Decision Number: OH20200103 02/07/2020

Superseded General Decision Number: OH20190103

State: Ohio

Construction Type: Building

County: Warren County in Ohio.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate,if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	02/07/2020

ASBE0008-010 07/01/2019

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR	$ 30.32	18.50

BROH0018-003 06/01/2019

	Rates	Fringes
BRICKLAYER	$ 27.01	15.02

BROH0018-005 09/01/2019

	Rates	Fringes
TILE SETTER	$ 28.74	14.06

CARP0002-016 05/01/2017

	Rates	Fringes
CARPENTER (Form Work Only)	$ 25.98	15.98

CARP0002-018 05/01/2017

	Rates	Fringes
CARPENTER (Includes Acoustical Ceiling Installation, Drywall Hanging and Metal Stud Installation; Excludes Form Work)	$ 24.04	15.29

ELEC0648-002 09/02/2019

	Rates	Fringes
ELECTRICIAN (Excludes Low Voltage Wiring)	$ 30.00	19.85

* ELEV0011-002 01/01/2020

	Rates	Fringes
ELEVATOR MECHANIC	$ 47.23	34.765+a+b

PAID HOLIDAYS:

a. New Year's Day, Memorial Day, Independence Day, Labor Day, Vetern's Day, Thanksgiving Day, the Friday after Thanksgiving, and Christmas Day.

b. Employer contributes 8% of regular hourly rate to vacation pay credit for employee who has worked in business more than 5 years; 6% for less than 5 years' service.

ENGI0018-036 05/01/2019

	Rates	Fringes
POWER EQUIPMENT OPERATOR Backhoe/Excavator/Trackhoe; Bulldozer; Crane	$ 37.14	15.20

ENGI0018-037 05/01/2018

	Rates	Fringes
POWER EQUIPMENT OPERATOR Bobcat/Skid Steer/Skid Loader	$ 35.89	15.09

ENGI0066-045 06/01/2017

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Forklift	$ 28.87	19.66
Grader/Blade	$ 32.42	19.66
Mechanic	$ 32.92	19.66

IRON0044-003 06/01/2017

	Rates	Fringes
IRONWORKER, REINFORCING	$ 27.60	20.70

IRON0044-020 06/01/2019

	Rates	Fringes
IRONWORKER, ORNAMENTAL	$ 29.47	21.20

LABO0265-019 06/01/2018

	Rates	Fringes
LABORER		
Mason Tender - Brick	$ 21.95	16.20

PAIN0123-001 05/01/2019

	Rates	Fringes

PAINTER (Brush and Roller)	$ 25.30	10.20

PAIN0387-002 11/01/2017

	Rates	Fringes
GLAZIER	$ 26.00	14.15

PLAS0132-018 06/01/2019

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 24.50	14.60

PLAS0132-019 06/22/2018

	Rates	Fringes
PLASTERER	$ 24.25	14.65

PLUM0392-004 06/01/2019

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe Installation, Excludes HVAC Unit Installation)	$ 32.81	21.27
PLUMBER (Includes HVAC Unit Installation, Excludes HVAC Pipe Installation)	$ 32.81	21.27

ROOF0042-007 08/01/2019

	Rates	Fringes
ROOFER	$ 28.25	16.27

SFOH0669-009 04/01/2019

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers)	$ 37.78	23.55

SHEE0024-029 06/01/2019

	Rates	Fringes
SHEET METAL WORKER (Including HVAC Duct Installation Only)	$ 30.16	21.08

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* UAVG-OH-0021 01/01/2019

	Rates	Fringes
OPERATOR: Oiler	$ 27.56	16.37

SUOH2012-105 08/29/2014

	Rates	Fringes
ELECTRICIAN (Low Voltage Wiring Only)	$ 22.62	8.76
IRONWORKER, STRUCTURAL	$ 25.24	17.80
LABORER: Asphalt, Includes Raker, Shoveler, Spreader and Distributor	$ 26.19	8.99
LABORER: Common or General	$ 23.09	7.41
LABORER: Landscape & Irrigation	$ 23.60	0.87
LABORER: Mason Tender - Cement/Concrete	$ 23.87	9.80
LABORER: Pipelayer	$ 23.18	8.95
OPERATOR: Loader	$ 29.66	12.61
OPERATOR: Paver (Asphalt, Aggregate, and Concrete)	$ 30.28	13.29
OPERATOR: Roller	$ 29.85	12.00
PAINTER: Spray	$ 22.78	12.40
TILE FINISHER	$ 22.31	10.24
TRUCK DRIVER: Dump (All Types)	$ 24.32	11.73

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave

for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

"General Decision Number: OH20200001 04/10/2020

Superseded General Decision Number: OH20190001

State: Ohio

Construction Types: Heavy and Highway

Counties: Ohio Statewide.

Heavy and Highway Construction Projects

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate,if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	01/24/2020
2	02/07/2020
3	03/13/2020
4	03/20/2020
5	04/10/2020

BROH0001-001 06/01/2019

DEFIANCE, FULTON (Excluding Fulton, Amboy & Swan Creek Townships), HENRY (Excluding Monroe, Bartlow, Liberty,

Washington, Richfield, Marion, Damascus & Townships & that part of Harrison Township outside corporate limits of city of Napoleon), PAULDING, PUTNAM and WILLIAMS COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0001-004 06/01/2019

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 29.34	16.11

BROH0003-002 06/01/2019

FULTON (Townships of Amboy, Swan Creek & Fulton), HENRY (Townships of Washington, Damascus, Richfield, Bartlow, Liberty, Harrison, Monroe, & Marion), LUCAS and WOOD (Townships of Perrysburg, Ross, Lake, Troy, Freedom, Montgomery, Webster, Center, Portage, Middleton, Plain, Liberty, Henry, Washington, Weston, Milton, Jackson & Grand Rapids) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0005-003 05/01/2019

CUYAHOGA, LORAIN & MEDINA (Hinckley, Granger, Brunswick, Liverpool, Montville, York, Homer, Harrisville, Chatham, Litchfield & Spencer Townships and the city of Medina)

	Rates	Fringes
BRICKLAYER		
BRICKLAYERS; CAULKERS; CLEANERS; POINTERS; & STONEMASONS	$ 34.85	16.94
SANDBLASTERS	$ 35.10	16.94
SEWER BRICKLAYERS & STACK BUILDERS	$ 35.35	16.94
SWING SCAFFOLDS	$ 35.35	16.94

BROH0006-005 06/01/2019

CARROLL, COLUMBIANA (Knox, Butler, West & Hanover Townships),

STARK & TUSCARAWAS

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0007-002 06/01/2019

LAWRENCE

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0007-005 06/01/2019

PORTAGE & SUMMIT

	Rates	Fringes
BRICKLAYER	$ 29.34	16.11

BROH0007-010 06/01/2019

PORTAGE & SUMMIT

	Rates	Fringes
MASON - STONE	$ 29.34	16.11

BROH0008-001 06/01/2019

COLUMBIANA (Salem, Perry, Fairfield, Center, Elk Run, Middleton, & Unity Townships and the city of New Waterford), MAHONING & TRUMBULL

	Rates	Fringes
BRICKLAYER	$ 29.34	16.11

BROH0009-002 06/01/2019

BELMONT & MONROE COUNTIES and the Townships of Warren & Mt. Pleasant and the Village of Dillonvale in JEFFERSON COUNTY

	Rates	Fringes

Bricklayer, Stonemason.....$ 29.34 16.11
Refractory.....$ 31.45 19.01

BROH0010-002 06/01/2019

COLUMBIANA (St. Clair, Madison, Wayne, Franklin, Washington, Yellow Creek & Liverpool Townships) & JEFFERSON (Brush Creek & Saline Townships)

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0014-002 06/01/2019

HARRISON & JEFFERSON (Except Mt. Pleasant, Warren, Brush Creek, Saline & Salineville Townships & the Village of Dillonvale)

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0016-002 06/01/2019

ASHTABULA, GEAUGA, and LAKE COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0018-002 06/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON, PREBLE (Gasper, Dixon, Israel, Lanier, Somers & Gratis Townships) & WARREN COUNTIES:

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0022-004 06/01/2019

CHAMPAIGN, CLARK, CLINTON, DARKE, GREENE, HIGHLAND, LOGAN, MIAMI, MONTGOMERY, PREBLE (Jackson, Monroe, Harrison, Twin, Jefferson & Washington Townships) and SHELBY COUNTIES

	Rates	Fringes

Bricklayer, Stonemason.....$ 29.34 16.11

BROH0032-001 06/01/2019

GALLIA & MEIGS

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0035-002 06/01/2019

ALLEN, AUGLAIZE, MERCER and VAN WERT COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0039-002 06/01/2019

ADAMS & SCIOTO

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0040-003 06/01/2019

ASHLAND, CRAWFORD, HARDIN, HOLMES, MARION, MORROW, RICHLAND, WAYNE and WYANDOT (Except Crawford, Ridge, Richland & Tymochtee Townships) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

FOOTNOTE: Layout Man and Sawman rate: $1.00 per hour above journeyman rate.
Free standing stack work ground level to top of stack; Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: $1.50 per hour above journeyman rate.
""Hot"" work: $2.50 above journeyman rate.

BROH0044-002 06/01/2019

	Rates	Fringes

Bricklayer, Stonemason
COSHOCTON, FAIRFIELD, GUERNSEY, HOCKING, KNOX, KICKING, MORGAN, MUSKINGUM, NOBLE (Beaver, Buffalo, Seneca & Wayne Townships) & PERRY COUNTIES:.....$ 29.34 16.11

BROH0045-002 06/01/2019

FAYETTE, JACKSON, PIKE, ROSS and VINTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 28.65	14.55

BROH0046-002 06/01/2019

ERIE, HANCOCK, HURON, OTTAWA, SANDUSKY, SENECA, WOOD (Perry & Bloom Townships) and WYANDOT (Tymochtee, Crawford, Ridge & Richland Townships) COUNTIES & the Islands of Lake Erie north of Sandusky

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

FOOTNOTE: Layout Man and Sawman rate: $1.00 per hour above journeyman rate.
Free standing stack work ground level to top of stack; Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: $1.50 per hour above journeyman rate.
""Hot"" work: $2.50 above journeyman rate.

BROH0052-001 06/01/2019

ATHENS COUNTY

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0052-003 06/01/2019

NOBLE (Brookfield, Noble, Center, Sharon, Olive, Enoch, Stock,

Jackson, Jefferson & Elk Townships) and WASHINGTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 29.34	16.11

BROH0055-003 06/01/2017

DELAWARE, FRANKLIN, MADISON, PICKAWAY and UNION COUNTIES

	Rates	Fringes
Bricklayer, Stonemason	$ 28.65	14.55

CARP0003-004 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
CARPENTER	$ 26.20	17.42

CARP0069-003 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
CARPENTER	$ 25.98	15.98

CARP0069-006 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
CARPENTER	$ 24.04	15.29

CARP0171-002 05/01/2019

BELMONT, COLUMBIANA, HARRISON, JEFFERSON & MONROE

	Rates	Fringes
CARPENTER	$ 27.37	20.02

CARP0200-002 05/01/2017

ADAMS, ATHENS, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GALLIA,

GUERNSEY, HIGHLAND, HOCKING, JACKSON, LAWRENCE, LICKING, MADISON, MARION, MEIGS, MORGAN, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE, ROSS, SCIOTO, UNION, VINTON and WASHINGTON COUNTIES

	Rates	Fringes
CARPENTER	$ 29.07	16.22
Diver	$ 39.41	10.40
PILEDRIVERMAN	$ 29.07	16.22

CARP0248-005 07/01/2008

LUCAS & WOOD

	Rates	Fringes
CARPENTER	$ 27.27	14.58

CARP0248-008 07/01/2008

	Rates	Fringes
CARPENTER		
DEFIANCE, FULTON, HANCOCK, HENRY, PAULDING & WILLIAMS COUNTIES	$ 23.71	13.28

CARP0254-002 05/01/2017

ASHTABULA, CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
CARPENTER	$ 32.40	16.97

CARP0372-002 05/01/2016

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM & VAN WERT

	Rates	Fringes
CARPENTER	$ 24.54	18.21

CARP0639-003 05/01/2017

MEDINA, PORTAGE & SUMMIT

	Rates	Fringes

CARPENTER	$ 30.42	16.99

CARP0735-002 05/01/2019

ASHLAND, ERIE, HURON, LORAIN & RICHLAND

	Rates	Fringes
CARPENTER	$ 26.30	17.91

CARP1311-001 05/01/2017

BROWN, BUTLER, CHAMPAIGN, CLARK, CLERMONT, CLINTON, DARKE, GREENE, HAMILTON, LOGAN, MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN

	Rates	Fringes
Carpenter & Piledrivermen	$ 29.34	15.95
Diver	$ 40.58	9.69

CARP1393-002 07/01/2008

CRAWFORD, DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Piledrivermen & Diver's Tender...	$ 27.30	16.05

DIVERS - $250.00 per day

CARP1393-003 07/01/2008

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM, VAN WERT & WYANDOT

	Rates	Fringes
Piledrivermen & Diver's Tender...	$ 25.15	15.92

DIVERS - $250.00 per day

CARP1871-006 05/01/2017

BELMONT, HARRISON, & MONROE

	Rates	Fringes

Diver, Wet	$ 48.11	17.33
Piledrivermen; Diver, Dry	$ 32.07	17.33

CARP1871-008 05/01/2017

ASHLAND, ASHTABULA, CUYAHOGA, ERIE, GEAUGA, HURON, LAKE, LORAIN, MEDINA, PORTAGE, RICHLAND & SUMMIT

	Rates	Fringes
Diver, Wet	$ 45.80	18.84
Piledrivermen; Diver, Dry	$ 30.53	18.84

CARP1871-014 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
Diver, Wet	$ 38.34	16.95
Piledrivermen; Diver, Dry	$ 25.56	16.95

CARP1871-015 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
Diver, Wet	$ 37.34	16.07
Piledrivermen; Diver, Dry	$ 24.89	16.07

CARP1871-017 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
Diver, Wet	$ 40.65	17.62
Piledrivermen; Diver, Dry	$ 27.10	17.62

CARP2235-012 01/01/2014

COLUMBIANA & JEFFERSON

	Rates	Fringes
PILEDRIVERMAN	$ 31.74	16.41

CARP2239-001 07/01/2008

CRAWFORD, OTTAWA, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
CARPENTER	$ 23.71	13.28

ELEC0008-002 05/27/2019

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
CABLE SPLICER	$ 38.98	18.96
ELECTRICIAN	$ 40.45	1.5%+20.23

ELEC0032-003 12/02/2019

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Ridgeland, Ridge & Salem Townships)

	Rates	Fringes
ELECTRICIAN	$ 31.37	19.24

ELEC0038-002 04/29/2019

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
ELECTRICIAN		
Excluding Sound & Communications Work	$ 39.13	20.69

FOOTNOTES;
a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

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ELEC0038-008 04/29/2019

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
Sound & Communication Technician		
Communications Technician	$ 27.55	11.98
Installer Technician	$ 26.30	11.94

FOOTNOTES;
a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

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ELEC0064-003 11/25/2019

COLUMBIANA (Butler, Fairfield, Perry, Salem & Unity Townships) MAHONING (Austintown, Beaver, Berlin, Boardman, Canfield, Ellsworth, Coitsville, Goshen, Green, Jackson, Poland, Springfield & Youngstown Townships), & TRUMBULL (Hubbard & Liberty Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.67	15.83

ELEC0071-001 01/01/2019

ASHLAND, CHAMPAIGN, CLARK, COSHOCTON, CRAWFORD, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GUERNSEY, HIGHLAND, HOCKING, JACKSON (Coal, Jackson, Liberty, Milton, Washington & Wellston Townships), KNOX, LICKING, MADISON, MARION, MONROE, MORGAN, MORROW, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, Peepee, Perry & Seal Townships), RICHLAND, ROSS, TUSCARAWAS (Auburn, Bucks, Clay, Jefferson, Oxford, Perry, Salem, Rush, Washington & York Townships), UNION, VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships), and WASHINGTON COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operators	$ 33.62	13.40

Groundmen	$ 24.17	11.32
Linemen & Cable Splicers	$ 38.27	14.42

ELEC0071-004 01/01/2019

AUGLAIZE, CLINTON, DARKE, GREENE, LOGAN, MERCER, MIAMI, MONTGOMERY, PREBLE, and SHELBY COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-005 12/31/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE & LORAIN

	Rates	Fringes
LINE CONSTRUCTION: Equipment Operator		
DOT/Traffic Signal & Highway Lighting Projects	$ 32.44	14.10
Municipal Power/Transit Projects	$ 40.10	16.42
LINE CONSTRUCTION: Groundman		
DOT/Traffic Signal & Highway Lighting Projects	$ 25.06	12.26
Municipal Power/Transit Projects	$ 31.19	14.11
LINE CONSTRUCTION: Linemen/Cable Splicer		
DOT/Traffic Signal & Highway Lighting Projects	$ 36.13	15.03
Municipal Power/Transit Projects	$ 44.56	17.58

ELEC0071-008 01/01/2019

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-010 01/01/2019

BELMONT, CARROLL, HARRISON, HOLMES, JEFFERSON, MEDINA, PORTAGE, STARK, SUMMIT, and WAYNE COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-013 01/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON, and WARREN COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0071-014 01/01/2019

ADAMS, ATHENS, GALLIA, JACKSON (Bloomfield, Franklin, Hamilton, Lick, Jefferson, Scioto & Madison Townships), LAWRENCE, MEIGS, PIKE (Camp Creek, Marion, Newton, Scioto, Sunfish & Union Townships), SCIOTO & VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships)

	Rates	Fringes
Line Construction		
Equipment Operator	$ 33.62	13.40
Groundman	$ 24.17	11.32
Lineman & Cable Splicers	$ 38.27	14.42

ELEC0082-002 12/02/2019

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
ELECTRICIAN	$ 31.15	19.96

ELEC0082-006 11/26/2018

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
Sound & Communication Technician		
Cable Puller	$ 12.18	3.85
Installer/Technician	$ 24.35	11.29

ELEC0129-003 03/25/2019

LORAIN (Except Columbia Township) & MEDINA (Litchfield & Liverpool Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.35	17.30

ELEC0129-004 03/25/2019

ERIE & HURON (Lyme, Ridgefield, Norwalk, Townsend, Wakeman, Sherman, Peru, Bronson, Hartland, Clarksfield, Norwich, Greenfield, Fairfield, Fitchville & New London Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.35	17.30

ELEC0141-003 09/01/2019

BELMONT COUNTY

	Rates	Fringes
CABLE SPLICER	$ 30.63	25.87
ELECTRICIAN	$ 30.38	25.87

ELEC0212-003 11/26/2018

BROWN, CLERMONT & HAMILTON

	Rates	Fringes

Sound & Communication
Technician.....$ 24.35 10.99

ELEC0212-005 06/03/2019

BROWN, CLERMONT, and HAMILTON COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.18	18.89

ELEC0245-001 01/01/2020

ALLEN, HARDIN, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Richland, Ridge & Salem Townships)

	Rates	Fringes
Line Construction		
Equipment Operator	$ 32.37	25.9%+6.75
Groundman Truck Driver	$ 17.70	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75

FOOTNOTE: a. Half day's Paid Holiday: The last 4 hours of the workday prior to Christmas or New Year's Day

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ELEC0245-003 01/01/2020

DEFIANCE, FULTON, HANCOCK, HENRY, HURON, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS, and WOOD COUNTIES

	Rates	Fringes
Line Construction		
Cable Splicer	$ 46.53	25.9%+6.75
Groundman/Truck Driver	$ 17.70	25.9%+6.75
Heli-arc Welding	$ 40.76	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75
Operator - Class 1	$ 32.37	25.9%+6.75
Operator - Class 2	$ 28.32	25.9%+6.75
Traffic Signal & Lighting Technician	$ 36.41	25.9%+6.75

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified

straight-time rates for the work performed on such holiday.

ELEC0245-004 01/01/2020

ERIE COUNTY

	Rates	Fringes
Line Construction		
Cable Splicer	$ 46.53	25.9%+6.75
Groundman/Truck Driver	$ 17.70	25.9%+6.75
Lineman	$ 40.46	25.9%+6.75
Operator - Class 1	$ 32.37	25.9%+6.75
Operator - Class 2	$ 28.32	25.9%+6.75

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

ELEC0246-001 10/29/2018

	Rates	Fringes
ELECTRICIAN	$ 38.00	84%+a

FOOTNOTE: a. 1 1/2 Paid Holidays: The last scheduled workday prior to Christmas & 4 hours on Good Friday.

ELEC0306-005 05/28/2018

MEDINA (Brunswick, Chatham, Granger, Guilford, Harrisville, Hinckley, Homer, Lafayette, Medina, Montville, Sharon, Spencer, Wadsworth, Westfield & York Townships), PORTAGE (Atwater, Aurora, Brimfield, Deerfield, Franklin, Mantua, Randolph, Ravenna, Rootstown, Shalersville, Streetsboro & Suffield Townships), SUMMIT & WAYNE (Baughman, Canaan, Chester, Chippewa, Congress, Green, Milton, & Wayne Townships)

	Rates	Fringes
CABLE SPLICER	$ 36.87	16.56
ELECTRICIAN	$ 34.54	5%+18.06

ELEC0317-002 06/01/2019

GALLIA & LAWRENCE

	Rates	Fringes
CABLE SPLICER	$ 32.68	18.13
ELECTRICIAN	$ 34.35	25.70

ELEC0540-005 01/01/2020

CARROLL (Northern half, including Fox, Harrison, Rose & Washington Townhships), COLUMBIANA (Knox Township), HOLMES, MAHONING (Smith Township), STARK, TUSCARAWAS (North of Auburn, Clay, Rush & York Townships), and WAYNE (South of Baughman, Chester, Green & Wayne Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 33.71	24.22

ELEC0573-003 11/25/2019

ASHTABULA (Colebrook, Wayne, Williamsfield, Orwell & Windsor Townships), GEAUGA (Auburn, Middlefield, Parkman & Troy Townships), MAHONING (Milton Township), PORTAGE (Charlestown, Edinburg, Freedom, Hiram, Nelson, Palmyra, Paris & Windham Townships), and TRUMBULL (Except Liberty & Hubbard Townships)

	Rates	Fringes
ELECTRICIAN	$ 34.21	19.24

ELEC0575-001 05/27/2019

ADAMS, FAYETTE, HIGHLAND, HOCKING, JACKSON (Bloomfield, Franklin, Hamilton, Jefferson, Lick, Madison, Scioto, Coal, Jackson, Liberty, Milton & Washington Townships), PICKAWAY (Deer Creek, Perry, Pickaway, Salt Creek & Wayne Townships), PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, PeePee, Perry, Seal, Camp Creek, Newton, Scioto, Sunfish, Union & Marion Townships), ROSS, SCIOTO & VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships)

	Rates	Fringes
ELECTRICIAN	$ 33.75	17.19

ELEC0648-001 09/02/2019

BUTLER and WARREN COUNTIES (Deerfield, Hamilton, Harlan, Massie, Salem, Turtle Creek, Union & Washington Townships)

	Rates	Fringes
CABLE SPLICER	$ 30.50	18.23
ELECTRICIAN	$ 30.00	19.85

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* ELEC0673-004 02/01/2020

ASHTABULA (Excluding Orwell, Colebrook, Williamsfield, Wayne & Windsor Townships), GEAUGA (Burton, Chardon, Claridon, Hambden, Huntsburg, Montville, Munson, Newbury & Thompson Townships) and LAKE COUNTIES

	Rates	Fringes
CABLE SPLICER	$ 33.81	21.47
ELECTRICIAN	$ 33.56	21.47

ELEC0683-002 05/27/2019

CHAMPAIGN, CLARK, DELAWARE, FAIRFIELD, FRANKLIN, MADISON, PICKAWAY (Circleville, Darby, Harrison, Jackson, Madison, Monroe, Muhlenberg, Scioto, Walnut & Washington Townships), and UNION COUNTIES

	Rates	Fringes
CABLE SPLICER	$ 34.50	21.20
ELECTRICIAN	$ 33.50	20.18

ELEC0688-003 12/02/2019

ASHLAND, CRAWFORD, HURON (Richmond, New Haven, Ripley & Greenwich Townships), KNOX (Liberty, Clinton, Union, Howard, Monroe, Middleberry, Morris, Wayne, Berlin, Pike, Brown & Jefferson Townships), MARION, MORROW, RICHLAND and WYANDOT (Sycamore, Crane, Eden, Pitt, Antrim & Tymochtee Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.00	18.86

ELEC0972-002 06/01/2019

ATHENS, MEIGS, MONROE, MORGAN, NOBLE, VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships), and WASHINGTON COUNITES

	Rates	Fringes
CABLE SPLICER	$ 33.80	26.65
ELECTRICIAN	$ 33.55	26.65

ELEC1105-001 05/28/2018

COSHOCTON, GUERNSEY, KNOX (Jackson, Clay, Morgan, Miller, Milford, Hilliar, Butler, Harrison, Pleasant & College Townships), LICKING, MUSKINGUM, PERRY, and TUSCARAWAS (Auburn, York, Clay, Jefferson, Rush, Oxford, Washington, Salem, Perry & Bucks Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 30.95	17.96

ENGI0018-003 05/01/2019

ASHTABULA, CUYAHOGA, ERIE, GEAUGA, LAKE, LORAIN, MEDINA, PORTAGE, and SUMMIT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1	$ 38.63	15.20
GROUP 2	$ 38.53	15.20
GROUP 3	$ 37.49	15.20
GROUP 4	$ 36.27	15.20
GROUP 5	$ 30.98	15.20
GROUP 6	$ 38.88	15.20
GROUP 7	$ 39.13	15.20

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker);

Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24"" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; Wheel Excavator; and Asphalt Plant Engineer (Cleveland District Only).

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48""; Bulldozer; Endloader; Horizontal Directional Drill (Over 50,000 ft lbs thrust); Hydro Milling Machine; Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24"" wide & under); Vermeer type Concrete Saw; and Maintenance Operators (Portage and Summit Counties Only).

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer (Portage and Summit Counties Only); Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4"" & over discharge); Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); Welding Machines; and Railroad Tie Inserter/Remover; Articulating/straight bed end dumps if assigned (minus $4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48"" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Forklift; Form Trencher; Hydro Hammer expect masonary; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonry Fork Lift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4"" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0018-004 05/01/2019

ADAMS, ALLEN, ASHLAND, ATHENS, AUGLAIZE, BELMONT, BROWN, BUTLER, CARROLL, CHAMPAIGN, CLARK, CLERMONT, CLINTON, COSHOCTON, CRAWFORD, DARKE, DEFIANCE, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, FULTON, GALLIA, GREENE, GUERNSEY, HAMILTON, HANCOCK, HARDIN, HARRISON, HENRY, HIGHLAND, HOCKING, HOLMES, HURON, JACKSON, JEFFERSON, KNOX, LAWRENCE, LICKING, LOGAN, LUCAS, MADISON, MARION, MEIGS, MERCER, MIAMI, MONROE, MONTGOMERY, MORGAN, MORROW, MUSKINGUM, NOBLE, OTTAWA, PAULDING, PERRY, PICKAWAY, PIKE, PREBLE, PUTNAM, RICHLAND, ROSS, SANDUSKY, SCIOTO, SENECA, SHELBY, STARK, TUSCARAWAS, UNION, VAN WERT, VINTON, WARREN, WASHINGTON, WAYNE, WILLIAMS, WOOD, and YANDOT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		

GROUP 1	$ 37.14	15.20
GROUP 2	$ 37.02	15.20
GROUP 3	$ 35.98	15.20
GROUP 4	$ 34.80	15.20
GROUP 5	$ 29.34	15.20
GROUP 6	$ 37.39	15.20
GROUP 7	$ 37.64	15.20

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker); Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24"" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; and Wheel Excavator.

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48""; Bulldozer; Endloader; Hydro Milling Machine; Horizontal Directional Drill (over 50,000 ft. lbs. thrust);Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24"" wide & under); and Vermeer type Concrete Saw.

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer; Bobcat-type and/or Skid

Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4"" & over discharge); Railroad Tie Inserter/Remover; Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); and Welding Machines; Artiaculating/straight bed end dumps if assigned (minus $4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48"" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Fork Lift; Form Trencher; Hydro Hammer expect masonary; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonary Forklift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4"" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0066-023 06/01/2017

COLUMBIANA, MAHONING & TRUMBULL COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 1 - A & B	$ 39.23	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 2 - A & B	$ 38.90	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 3 - A & B	$ 34.64	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 4 - A & B	$ 30.70	19.66
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 5 - A & B	$ 27.30	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 1 - C & D	$ 35.96	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 2 - C & D	$ 35.66	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 3 - C & D	$ 31.76	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 4 - C & D	$ 28.14	19.66
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 5 - C & D	$ 25.03	19.66
ALL OTHER WORK		
GROUP 1	$ 32.69	19.66
ALL OTHER WORK		
GROUP 2	$ 32.42	19.66
ALL OTHER WORK		
GROUP 3	$ 28.87	19.66
ALL OTHER WORK		
GROUP 4	$ 25.58	19.66
ALL OTHER WORK		
GROUP 5	$ 22.75	19.66

GROUP 1 - Rig, Pile Driver or Caisson Type; & Rig, Pile Hydraulic Unit Attached

GROUP 2 - Asphalt Heater Planer; Backfiller with Drag Attachment; Backhoe; Backhoe with Shear attached; Backhoe-Rear Pivotal Swing; Batch Plant-Central Mix Concrete; Batch Plant, Portable concrete; Berm Builder-Automatic; Boat Derrick; Boat-Tug; Boring Machine Attached to Tractor; Bullclam; Bulldozer; C.M.I. Road Builder & Similar Type; Cable Placer & Layer; Carrier-Straddle; Carryall-Scraper or Scoop; Chicago Boom; Compactor with Blade Attached; Concrete Saw (Vermeer or similar type); Concrete Spreader Finisher; Combination, Bidwell Machine; Crane; Crane-Electric Overhead; Crane-Rough Terrain; Crane-Side Boom; Crane-Truck; Crane-Tower; Derrick-Boom; Derrick-Car; Digger-Wheel (Not trencher or road widener); Double Nine; Drag Line; Dredge; Drill-Kenny or Similar Type; Easy Pour Median Barrier Machine (or similar type); Electromatic; Frankie Pile; Gradall; Grader; Gurry; Self-Propelled; Heavy Equipment Robotics Operator/Mechanic; Hoist-Monorail; Hoist-Stationary & Mobile Tractor; Hoist, 2 or 3 drum; Horizontal Directional Drill Operator; Jackall; Jumbo Machine; Kocal & Kuhlman; Land-Seagoing Vehicle; Loader, Elevating; Loader, Front End; Loader, Skid Steer; Locomotive; Mechanic/Welder; Metro Chip Harvester with Boom; Mucking Machine; Paver-Asphalt Finishing Machine; Paver-Road Concrete; Paver-Slip Form (C.M.I. or similar); Place Crete Machine with Boom; Post Driver (Carrier mounted); Power Driven Hydraulic Pump & Jack (When used in Slip Form or Lift Slab Construction); Pump Crete Machine; Regulator-Ballast; Hydraulic Power Unit not attached to Rig for Pile Drillings; Rigs-Drilling; Roto Mill or similar Full Lane (8' Wide & Over); Roto Mill or similar type (Under 8'); Shovel; Slip Form Curb Machine; Speedwing; Spikemaster; Stonecrusher; Tie Puller & Loader; Tie Tamper; Tractor-Double Boom; Tractor with Attachments; Truck-Boom; Truck-Tire; Trench Machine; Tunnel Machine (Mark 21 Java or similar); & Whirley (or similar type)

GROUP 3 - Asphalt Plant; Bending Machine (Pipeline or similar type); Boring machine, Motor Driven; Chip Harvester without Boom; Cleaning Machine, Pipeline Type; Coating Machine, Pipeline Type; Compactor; Concrete Belt Placer; Concrete Finisher; Concrete Planer or Asphalt; Concrete Spreader; Elevator; Fork Lift (Home building only); Fork lift & Lulls; Fork Lift Walk Behind (Hoisting over 1 buck high); Form Line Machine; Grease Truck operator; Grout Pump; Gunnite Machine; Horizontal Directional Drill Locator; Single Drum Hoist with or without Tower; Huck Bolting Machine; Hydraulic Scaffold (Hoisting building materials); Paving Breaker (Self-propelled or Ridden); Pipe Dream; Pot Fireperson (Power Agitated); Refrigeration Plant; Road Widener; Roller; Sasgen Derrick; Seeding Machine; Soil Stabilizer (Pump type); Spray Cure Machine, Self-Propelled; Straw Blower Machine; Sub-Grader; Tube Finisher or Broom C.M.I. or similar type; & Tugger Hoist

GROUP 4 - Air Curtain Destructor & Similar Type; Batch Plant-Job Related; Boiler Operator; Compressor; Conveyor; Curb Builder, self-propelled; Drill Wagon; Generator Set; Generator-Steam; Heater-Portable Power; Hydraulic Manipulator Crane; Jack-Hydraulic Power driven; Jack-Hydraulic (Railroad); Ladavator; Minor Machine Operator; Mixer-Concrete; Mulching Machine; Pin Puller; Power Broom; Pulverizer; Pump; Road Finishing Machine (Pull Type); Saw-Concrete-Self-Propelled (Highway Work); Signal Person; Spray Cure Machine-Motor Powered; Stump Cutter; Tractor; Trencher Form; Water Blaster; Steam Jenny; Syphon; Vibrator-Gasoline; & Welding Machine

GROUP 5 - Brakeperson; Fireperson; & Oiler

IRON0017-002 05/01/2019

ASHTABULA (North of Route 6, starting at the Geauga County Line, proceeding east to State Route 45), CUYAHOGA, ERIE (Eastern 2/3), GEAUGA, HURON (East of a line drawn from the north border through Monroeville & Willard), LAKE, LORAIN, MEDINA (North of Old Rte. #224), PORTAGE (West of a line from Middlefield to Shalersville to Deerfield), and SUMMIT (North of Old Rte. #224, including city limits of Barberton) COUNTIES

	Rates	Fringes
IRONWORKER		
Ornamental, Reinforcing, & Structural	$ 34.93	22.00

IRON0017-010 05/01/2019

ASHTABULA (Eastern part from Lake Erie on the north to route #322 on the south to include Conneaut, Kingsville, Sheffield,

Denmark, Dorset, Cherry Valley, Wayne, Monroe, Pierpont, Richmond, Andover & Williamsfield Townships)

	Rates	Fringes
IRONWORKER		
Structural, including metal building erection & Reinforcing	$ 34.93	22.00

IRON0044-001 06/01/2018

ADAMS (Western Part), BROWN, BUTLER (Southern Part), CLERMONT, CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) and WARREN (South of a line drawn from Blanchester through Morrow to the west county line) COUNTIES

	Rates	Fringes
IRONWORKER, REINFORCING		
Beyond 30-mile radius of Hamilton County Courthouse	$ 28.67	21.20
Up to & including 30-mile radius of Hamilton County Courthouse	$ 27.60	20.70

IRON0044-002 06/01/2019

CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) & WARREN (South of a line drawn from Blanchester through Morrow to the west county line)

	Rates	Fringes
IRONWORKER		
Fence Erector	$ 28.00	21.20
Ornamental; Structural	$ 29.47	21.20

IRON0055-003 07/01/2019

CRAWFORD (Area Between lines drawn from where Hwy #598 & #30

meet through N. Liberty to the northern border & from said Hwy junction point due west to the border), DEFIANCE (S. of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), ERIE (Western 1/3), FULTON, HANCOCK, HARDIN (North of a line drawn from Maysville to a point 4 miles south of the northern line on the eastern line), HENRY, HURON (West of a line drawn from the northern border through Monroeville & Willard), LUCAS, OTTAWA, PUTNAM (East of a line drawn from the northern border down through Miller City to where #696 meets the southern border), SANDUSKY, SENECA, WILLIAMS (East of a line drawn from Pioneer through Stryker to the southern border), WOOD & WYANDOT (North of Rte. #30)

	Rates	Fringes
IRONWORKER		
Fence Erector	$ 21.30	20.92
Flat Road Mesh	$ 29.77	21.30
Tunnels & Caissons Under Pressure	$ 29.77	21.30
All Other Work	$ 30.38	24.40

IRON0147-002 06/01/2015

ALLEN (Northern half), DEFIANCE (Northern part, excluding south of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), MERCER (Northern half), PAULDING, PUTNAM (Western part, excluding east of a line drawn from the northern border down through Miller City to where #696 meets the southern border), VAN WERT, and WILLIAMS (Western part, excluding east of a line drawn from Pioneer through Stryker to the southern border) COUNTIES

	Rates	Fringes
IRONWORKER	$ 25.39	20.64

IRON0172-002 06/01/2019

CHAMPAIGN (Eastern one-third), CLARK (Eastern one-fourth), COSHOCTON (West of a line beginning at the northwestern county line going through Walhonding & Tunnel Hill to the southern county line), CRAWFORD (South of Rte. #30), DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, HARDIN (Excluding a line drawn from Roundhead to Maysville), HIGHLAND (Eastern one-fifth), HOCKING, JACKSON (Northern half), KNOX, LICKING, LOGAN (Eastern one-third), MADISON, MARION, MORROW, MUSKINGUM (West of a line

starting at Adams Mill going to Adamsville & going from Adamsville through Blue Rock to the southern border), PERRY, PICKAWAY, PIKE (Northern half), ROSS, UNION, VINTON and WYANDOT (South of Rte. #30) COUNTIES

	Rates	Fringes
IRONWORKER	$ 30.00	20.70

IRON0207-004 06/01/2019

ASHTABULA (Southern part starting at the Geauga County line), COLUMBIANA (E. of a line from Damascus to Highlandtown), MAHONING (N. of Old Route #224), PORTAGE (E. of a line from Middlefield to Shalersville to Deerfield) & TRUMBULL

	Rates	Fringes
IRONWORKER		
Layout; Sheeter	$ 30.72	25.15
Ornamental; Reinforcing; Structural	$ 28.06	24.70
Ornamental; Reinforcing	$ 29.72	25.18

IRON0290-002 06/01/2019

ALLEN (Southern half), AUGLAIZE, BUTLER (North of a line drawn from east to the west county line going through Oxford, Darrtown & Woodsdale), CHAMPAIGN (Excluding east of a line drawn from Catawla to the point where #68 intersects the northern county line), CLARK (Western two-thirds), CLINTON (Excluding south of a line drawn from Blanchester to Lynchburg), DARKE, GREENE, HIGHLAND (Inside lines drawn from Marshall to Lynchburg & from the northern county line through East Monroe to Marshall), LOGAN (West of a line drawn from West Liberty to where the northern county line meets the western county line of Hardin), MERCER (Southern half), MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN (Excluding south of a line drawn from Blanchester through Morrow to the western county line) COUNTIES

	Rates	Fringes
IRONWORKER	$ 29.23	33.35

IRON0549-003 12/01/2018

BELMONT, GUERNSEY, HARRISON, JEFFERSON, MONROE & MUSKINGUM (Excluding portion west of a line starting at Adams Mill going to Adamsville and going from Adamsville through Blue Rock to the south border)

	Rates	Fringes
IRONWORKER	$ 33.34	20.81

IRON0550-004 05/01/2019

ASHLAND, CARROLL, COLUMBIANA (W. of a line from Damascus to Highlandtown), COSHOCTON (E. of a line beginning at NW Co. line going through Walhonding & Tunnel Hill to the South Co. line), HOLMES, HURON (S. of Old Rte. #224), MAHONING (S. of Old Rte. #224), MEDINA (S. of Old Rte. #224), PORTAGE (S. of Old Rte. #224), RICHLAND, STARK, SUMMIT (S. of Old Rte. #224, Excluding city limits of Barberton), TUSCARAWAS, & WAYNE

	Rates	Fringes
Ironworkers:Structural, Ornamental and Reinforcing	$ 28.90	19.87

IRON0769-004 06/01/2019

ADAMS (Eastern Half), GALLIA, JACKSON (Southern Half), LAWRENCE & SCIOTO

	Rates	Fringes
IRONWORKER	$ 32.00	25.95

IRON0787-003 12/01/2019

ATHENS, MEIGS, MORGAN, NOBLE, and WASHINGTON COUNTIES

	Rates	Fringes
IRONWORKER	$ 30.18	22.75

LABO0265-008 05/01/2018

	Rates	Fringes
LABORER		
ASHTABULA, ERIE, HURON,		

LORAIN, LUCAS, MAHONING,
MEDINA, OTTAWA, PORTAGE,
SANDUSKY, STARK, SUMMIT,
TRUMBULL & WOOD COUNTIES
GROUP 1.....$ 31.05 10.95
GROUP 2.....$ 31.22 10.95
GROUP 3.....$ 31.55 10.95
GROUP 4.....$ 32.00 10.95
CUYAHOGA AND GEAUGA
COUNTIES ONLY: SEWAGE
PLANTS, WASTE PLANTS,
WATER TREATMENT
FACILITIES, PUMPING
STATIONS, & ETHANOL PLANTS
CONSTRUCTION.....$ 33.66 10.95
CUYAHOGA, GEAUGA & LAKE
COUNTIES
GROUP 1.....$ 32.28 10.95
GROUP 2.....$ 32.45 10.95
GROUP 3.....$ 32.78 10.95
GROUP 4.....$ 33.23 10.95
REMAINING COUNTIES OF OHIO
GROUP 1.....$ 30.62 10.95
GROUP 2.....$ 30.79 10.95
GROUP 3.....$ 31.12 10.95
GROUP 4.....$ 31.57 10.95

LABORER CLASSIFICATIONS

GROUP 1 - Asphalt Laborer; Carpenter Tender; Concrete Curing Applicator; Dump Man (Batch Truck); Guardrail and Fence Installer; Joint Setter; Laborer (Construction); Landscape Laborer; Mesh Handlers & Placer; Right-of-way Laborer; Riprap Laborer & Grouter; Scaffold Erector; Seal Coating; Surface Treatment or Road Mix Laborer; Sign Installer; Slurry Seal; Utility Man; Bridge Man; Handyman; Waterproofing Laborer; Flagperson; Hazardous Waste (level D); Diver Tender; Zone Person & Traffic Control

GROUP 2 - Asphalt Raker; Concrete Puddler; Kettle Man Pipeline); Machine Driven Tools (Gas, Electric, Air); Mason Tender; Brick Paver; Mortar Mixer; Power Buggy or Power Wheelbarrow; Paint Striper; Sheeting & Shoring Man; Surface Grinder Man; Plastic Fusing Machine Operator; Pug Mill Operator; & Vacuum Devices (wet or dry); Rodding Machine Operator; Diver; Screwman or Paver; Screed Person; Water Blast, Hand Held Wand; Pumps 4"" & Under (Gas, Air or Electric) & Hazardous Waste (level C); Air Track and Wagon Drill; Bottom Person; Cofferdam (below 25 ft. deep); Concrete Saw Person; Cutting with Burning Torch; Form

Setter; Hand Spiker (Railroad); Pipelayer; Tunnel Laborer (without air) & Caisson; Underground Person (working in Sewer and Waterline, Cleaning, Repairing & Reconditioning); Sandblaster Nozzle Person; & Hazardous Waste (level B)

GROUP 3 - Blaster; Mucker; Powder Person; Top Lander; Wrencher (Mechanical Joints & Utility Pipeline); Yarner; Hazardous Waste (level A); Concrete Specialist; Concrete Crew in Tunnels (With Air-pressurized - $1.00 premium); Curb Setter & Cutter; Grade Checker; Utility Pipeline Tapper; Waterline; and Caulker

GROUP 4 - Miner (With Air-pressurized - $1.00 premium); & Gunite Nozzle Person

TUNNEL LABORER WITH AIR-PRESSURIZED ADD $1.00 TO BASE RATE

SIGNAL PERSON WILL RECEIVE THE RATE EQUAL TO THE RATE PAID THE LABORER CLASSIFICATION FOR WHICH HE OR SHE IS SIGNALING.

PAIN0006-002 05/01/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN, PORTAGE (N. of the East-West Turnpike) & SUMMIT (N. of the East-West Turnpike)

	Rates	Fringes
PAINTER		
COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS		
GROUP 1	$ 27.90	16.16
GROUP 2	$ 28.30	16.16
GROUP 3	$ 28.60	16.16
GROUP 4	$ 34.16	16.16
COMMERCIAL REPAINT		
GROUP 1	$ 26.40	16.16
GROUP 2	$ 26.80	16.16
GROUP 3	$ 27.10	16.16

PAINTER CLASSIFICATIONS - COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting; Closed Steel Above 55 feet; Bridges & Open Structural Steel; Tanks - Water Towers; Bridge

Painters; Bridge Riggers; Containment Builders

GROUP 4 - Bridge Blaster

PAINTER CLASSIFICATIONS - COMMERCIAL REPAINT

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting

PAIN0007-002 07/01/2019

FULTON, HENRY, LUCAS, OTTAWA (Excluding Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genova) & WOOD

	Rates	Fringes
PAINTER		
NEW COMMERCIAL WORK		
GROUP 1	$ 27.64	17.79
GROUP 2	$ 27.39	17.79
GROUP 3	$ 27.39	17.79
GROUP 4	$ 27.39	17.79
GROUP 5	$ 27.39	17.79
GROUP 6	$ 27.39	17.79
GROUP 7	$ 27.39	17.79
GROUP 8	$ 27.39	17.79
GROUP 9	$ 27.39	17.79

REPAINT IS 90% OF JR

PAINTER CLASSIFICATIONS

GROUP 1 - Brush; Spray & Sandblasting Pot Tender

GROUP 2 - Refineries & Refinery Tanks; Surfaces 30 ft. or over where material is applied to or labor performed on above ground level (exterior), floor level (interior)

GROUP 3 - Swing Stage & Chair

GROUP 4 - Lead Abatement

GROUP 5 - All Methods of Spray

GROUP 6 - Solvent-Based Catalized Epoxy Materials of 2 or More Component Materials, to include Solvent-Based Conversion Varnish (excluding water based)

GROUP 7 - Spray Solvent Based Material; Sand & Abrasive Blasting

GROUP 8 - Towers; Tanks; Bridges; Stacks Over 30 Feet

GROUP 9 - Epoxy Spray (excluding water based)

PAIN0012-008 05/01/2019

BUTLER COUNTY

	Rates	Fringes
PAINTER		
GROUP 1	$ 21.95	10.20
GROUP 2	$ 25.30	10.20
GROUP 3	$ 25.80	10.20
GROUP 4	$ 26.05	10.20
GROUP 5	$ 26.30	10.20

PAINTER CLASSIFICATIONS

GROUP 1: Bridge Equipment Tender; Bridge/Containment Builder

GROUP 2: Brush & Roller

GROUP 3: Spray

GROUP 4: Sandblasting; & Waterblasting

GROUP 5: Elevated Tanks; Steeplejack Work; Bridge; & Lead Abatement

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PAIN0012-010 05/01/2019

BROWN, CLERMONT, CLINTON, HAMILTON & WARREN

	Rates	Fringes
PAINTER		
HEAVY & HIGHWAY BRIDGES-		
GUARDRAILS-LIGHTPOLES-		

STRIPING
Bridge Equipment Tender
and Containment Builder....$ 21.95 10.20
Bridges when highest
point of clearance is 60
feet or more; & Lead
Abatement Projects.....$ 26.30 10.20
Brush & Roller.....$ 25.30 10.20
Sandblasting & Hopper
Tender; Water Blasting.....$ 26.05 10.20
Spray.....$ 25.80 10.20

PAIN0093-001 12/01/2018

ATHENS, GUERNSEY, HOCKING, MONROE, MORGAN, NOBLE and WASHINGTON COUNTIES

	Rates	Fringes
PAINTER		
Bridges; Locks; Dams; Tension Towers; & Energized Substations	$ 34.04	18.50
Power Generating Facilities	$ 30.89	18.50

PAIN0249-002 05/01/2019

CLARK, DARKE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
PAINTER		
GROUP 1 - Brush & Roller	$ 23.67	11.50
GROUP 2 - Swing, Scaffold Bridges; Structural Steel; Open Acid Tank; High Tension Electrical Equipment; & Hot Pipes	$ 23.67	11.50
GROUP 3 - Spray; Sandblast; Steamclean; Lead Abatement	$ 24.42	11.50
GROUP 4 - Steeplejack Work	$ 24.62	11.50
GROUP 5 - Coal Tar	$ 25.17	11.50
GROUP 6 - Bridge Equipment Tender & or Containment Builder	$ 32.38	11.50
GROUP 7 - Tanks, Stacks & Towers	$ 27.31	11.50

GROUP 8 - Bridge Blaster, Rigger	$ 35.38	11.50

PAIN0356-002 09/01/2009

KNOX, LICKING, MUSKINGUM, and PERRY

	Rates	Fringes
PAINTER		
Bridge Equipment Tenders and Containment Builders	$ 27.93	7.25
Bridges; Blasters; andRiggers	$ 34.60	7.25
Brush and Roller	$ 20.93	7.25
Sandblasting; Steam Cleaning; Waterblasting; and Hazardous Work	$ 25.82	7.25
Spray	$ 21.40	7.25
Structural Steel and Swing Stage	$ 25.42	7.25
Tanks; Stacks; and Towers	$ 28.63	7.25

PAIN0438-002 12/01/2018

BELMONT, HARRISON and JEFFERSON COUNTIES

	Rates	Fringes
PAINTER		
Bridges, Locks, Dams, Tension Towers & Energized Substations	$ 32.80	17.68
Power Generating Facilities	$ 29.65	17.68

PAIN0476-001 06/01/2019

COLUMBIANA, MAHONING, and TRUMBULL COUNITES

	Rates	Fringes
PAINTER		
GROUP 1	$ 25.82	16.58
GROUP 2	$ 32.45	16.58
GROUP 3	$ 26.03	16.58
GROUP 4	$ 26.47	16.58
GROUP 5	$ 26.47	16.58
GROUP 6	$ 26.72	16.58
GROUP 7	$ 27.82	16.58

PAINTER CLASSIFICATIONS:

GROUP 1: Painters, Brush & Roller

GROUP 2: Bridges

GROUP 3: Structural Steel

GROUP 4: Spray, Except Bar Joist/Deck

GROUP 5: Epoxy/Mastic; Spray- Bar Joist/Deck; Working Above 50 Feet; and Swingstages

GROUP 6: Tanks; Sandblasting

GROUP 7: Towers; Stacks

PAIN0555-002 06/01/2019

ADAMS, HIGHLAND, JACKSON, PIKE & SCIOTO

	Rates	Fringes
PAINTER		
GROUP 1	$ 31.04	16.31
GROUP 2	$ 32.50	16.31
GROUP 3	$ 33.96	16.31
GROUP 4	$ 36.82	16.31

PAINTER CLASSIFICATIONS

GROUP 1 - Containment Builder

GROUP 2 - Brush; Roller; Power Tools, Under 40 feet

GROUP 3 - Sand Blasting; Spray; Steam Cleaning; Pressure Washing; Epoxy & Two Component Materials; Lead Abatement; Hazardous Waste; Toxic Materials; Bulk & Storage Tanks of 25,000 Gallon Capacity or More; Elevated Tanks

GROUP 4 - Stacks; Bridges

PAIN0639-001 05/01/2011

	Rates	Fringes
Sign Painter & Erector	$ 20.61	3.50+a+b+c

FOOTNOTES: a. 7 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; Christmas Day & 1 Floating Day
b. Vacation Pay: After 1 year's service - 5 days' paid vacation; After 2, but less than 10 years' service - 10 days' paid vacation; After 10, but less than 20 years' service - 15 days' paid vacation; After 20 years' service - 20 days' paid vacation
c. Funeral leave up to 3 days maximum paid leave for death of mother, father, brother, sister, spouse, child, mother-in-law, father-in-law, grandparent and inlaw provided employee attends funeral

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PAIN0788-002 06/01/2019

ASHLAND, CRAWFORD, ERIE, HANCOCK, HURON, MARION, MORROW, OTTAWA (Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genoa), RICHLAND, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
PAINTER		
Brush & Roller	$ 24.66	14.05
Structural Steel	$ 26.26	14.05

WINTER REPAINT: Between December 1 to March 31 - 90%JR

$.50 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

While working swingstage, boatswain chair, needle beam and horizontal cable. While operating sprayguns, sandblasting, cobblasting and high pressure waterblasting (4000psi).

$1.00 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

For the application of catalized epoxy, including latex epoxy that is deemed hazardous, lead abatement, or for work or material where special precautions beyond normal work duties must be taken. For working on stacks, tanks, and towers over 40 feet in height.

PAIN0813-005 12/01/2008

GALLIA, LAWRENCE, MEIGS & VINTON

	Rates	Fringes
PAINTER		
Base Rate	$ 24.83	10.00
Bridges, Locks, Dams & Tension Towers	$ 27.83	10.00

PAIN0841-001 06/01/2018

MEDINA, PORTAGE (South of and including Ohio Turnpike), and SUMMIT (South of and including Ohio Turnpike) COUNTIES

	Rates	Fringes
Painters:		
GROUP 1	$ 25.75	14.35
GROUP 2	$ 26.40	14.35
GROUP 3	$ 26.50	14.35
GROUP 4	$ 26.60	14.35
GROUP 5	$ 27.00	14.35
GROUP 6	$ 39.20	11.75
GROUP 7	$ 27.00	14.35

PAINTER CLASSIFICATIONS:

GROUP 1 - Brush, Roller & Paperhanger

GROUP 2 - Epoxy Application

GROUP 3 - Swing Scaffold, Bosum Chair, & Window Jack

GROUP 4 - Spray Gun Operator of Any & All Coatings

GROUP 5 - Sandblast, Painting of Standpipes, etc. from Scaffolds, Bridge Work and/or Open Structural Steel, Standpipes and/or Water Towers

GROUP 6 - Public & Commerce Transportation, Steel or Galvanized, Bridges, Tunnels & Related Support Items (concrete)

GROUP 7 - Synthetic Exterior, Drywall Finisher and/or Taper, Drywall Finisher and Follow-up Man Using Automatic Tools

PAIN0841-002 06/01/2018

CARROLL, COSHOCTON, HOLMES, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
PAINTER		
Bridges; Towers, Poles & Stacks; Sandblasting Steel; Structural Steel & Metalizing	$ 22.78	13.63
Brush & Roller	$ 21.77	13.63
Spray; Tank Interior & Exterior	$ 22.60	13.63

PAIN1020-002 04/01/2019

ALLEN, AUGLAIZE, CHAMPAIGN, DEFIANCE, HARDIN, LOGAN, MERCER, PAULDING, PUTNAM, SHELBY, VAN WERT, and WILLIAMS COUNTIES

	Rates	Fringes
PAINTER		
Brush & Roller	$ 24.57	15.03
Drywall Finishing & Taping	$ 23.27	15.03
Lead Abatement	$ 26.32	15.03
Spray, Sandblasting Pressure Cleaning, & Refinery	$ 25.32	15.03
Swing Stage, Chair, Spiders, & Cherry Pickers	$ 24.82	15.03
Wallcoverings	$ 22.17	15.03

All surfaces 40 ft. or over where material is applied to or labor performed on, above ground level (exterior), floor level (interior) - $.50 premium

Applying Coal Tar Products - $1.00 premium

PAIN1275-002 05/01/2019

DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, MADISON, PICKAWAY, ROSS & UNION

	Rates	Fringes
PAINTER		
Bridges	$ 34.24	14.20
Brush; Roller	$ 24.76	14.20
Sandblasting; Steamcleaning; Waterblasting (3500 PSI or Over)& Hazardous Work	$ 25.46	14.20
Spray	$ 25.26	14.20
Stacks; Tanks; & Towers	$ 28.27	14.20
Structural Steel & Swing Stage	$ 25.06	14.20

PLAS0109-001 05/01/2018

MEDINA, PORTAGE, STARK, and SUMMIT COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0109-003 05/01/2018

CARROLL, HOLMES, TUSCARAWAS, and WAYNE COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLAS0132-002 05/01/2018

BROWN, BUTLER, CLERMONT, HAMILTON, HIGHLAND, WARREN COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0404-002 05/01/2018

ASHTABULA, CUYAHOGA, GEAUGA, AND LAKE COUNTIES

	Rates	Fringes
PLASTERER	$ 29.63	17.11

PLAS0404-003 05/01/2018

LORAIN COUNTY

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0526-022 05/01/2018

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0526-023 05/01/2018

BELMONT, HARRISON, and JEFFERSON COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLAS0886-001 05/01/2018

FULTON, HANCOCK, HENRY, LUCAS, PUTNAM, and WOOD COUNTIES

	Rates	Fringes
PLASTERER	$ 29.63	17.11

PLAS0886-003 05/01/2018

DEFIANCE, ERIE, HURON, OTTAWA, PAULDING, SANDUSKY, and SENECA COUNTIES

	Rates	Fringes
PLASTERER	$ 28.86	17.11

PLAS0886-004 05/01/2018

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, and VAN WERT COUNTIES

	Rates	Fringes
PLASTERER	$ 28.21	17.11

PLUM0042-002 07/01/2018

ASHLAND, CRAWFORD, ERIE, HURON, KNOX, LORAIN, MORROW, RICHLAND & WYANDOT

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 34.20	22.07

PLUM0050-002 07/01/2019

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 42.00	26.73

PLUM0055-003 04/29/2019

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, MEDINA (N. of Rte. #18 & Smith Road) & SUMMIT (N. of Rte. #303, including the corporate limits of the city of Hudson)

	Rates	Fringes
PLUMBER	$ 36.55	26.74

PLUM0083-001 07/01/2017

BELMONT & MONROE (North of Rte. #78)

	Rates	Fringes
Plumber and Steamfitter	$ 32.16	31.51

PLUM0094-002 05/01/2019

CARROLL (Northen Half), STARK, and WAYNE COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 35.78	20.14

PLUM0120-002 04/30/2018

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN (the C.E.I. Power House in Avon Lake), MEDINA (N. of Rte. #18) & SUMMIT (N. of #303)

	Rates	Fringes
PIPEFITTER	$ 37.67	22.42

PLUM0162-002 01/01/2020

CHAMPAIGN, CLARK, CLINTON, DARKE, FAYETTE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 31.25	25.52

PLUM0168-002 06/01/2019

MEIGS, MONROE (South of Rte. #78), MORGAN (South of Rte. #78) & WASHINGTON

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 35.32	31.63

PLUM0189-002 06/01/2019

DELAWARE, FAIRFIELD, FRANKLIN, HOCKING, LICKING, MADISON, MARION, PERRY, PICKAWAY, ROSS & UNION

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 38.45	16.98

PLUM0219-002 05/31/2018

MEDINA (Rte. #18 from eastern edge of Medina Co., west to eastern corporate limits of the city of Medina, & on the county road from the west corporate limits of Medina running due west to and through community of Risley to the western edge of Medina County - All territory south of this line), PORTAGE, and SUMMIT (S. of Rte. #303) COUNTIES

	Rates	Fringes
Plumber and Steamfitter	$ 37.02	23.79

PLUM0392-002 06/01/2019

BROWN, BUTLER, CLERMONT, HAMILTON & WARREN

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 32.81	21.27

PLUM0396-001 06/01/2019

COLUMBIANA (Excluding Washington & Yellow Creek Townships & Liverpool Twp. - Secs. 35 & 36 - West of County Road #427), MAHONING and TRUMBULL COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 34.00	25.46

PLUM0495-002 06/01/2018

CARROLL (Rose, Monroe, Union, Lee, Orange, Perry & Loudon Townships), COLUMBIANA (Washington & Yellow Creek Townships & Liverpool Township, Secs. 35 & 36, West of County Rd. #427), COSHOCTON, GUERNSEY, HARRISON, HOLMES, JEFFERSON, MORGAN (South to State Rte. #78 & from McConnelsville west on State Rte. #37 to the Perry County line), MUSKINGUM, NOBLE, and TUSCARAWAS COUNTIES

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 38.24	23.09

PLUM0577-002 06/01/2019

ADAMS, ATHENS, GALLIA, HIGHLAND, JACKSON, LAWRENCE, PIKE, SCIOTO & VINTON

	Rates	Fringes
Plumber, Pipefitter, Steamfitter	$ 34.90	24.11

PLUM0776-002 08/01/2019

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY and VAN WERT COUNTIES

	Rates	Fringes

Plumber, Pipefitter, Steamfitter	$ 36.64	24.73

TEAM0377-003 05/01/2019

STATEWIDE, EXCEPT CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 28.04	15.70
GROUP 2	$ 28.46	15.70

TRUCK DRIVER CLASSIFICATIONS

GROUP 1 - Asphalt Distributor; Batch; 4- Wheel Service; 4-Wheel Dump; Oil Distributor & Tandem

GROUP 2 - Tractor-Trailer Combination: Fuel; Pole Trailer; Ready Mix; Semi-Tractor; & Asphalt Oil Spraybar Man When Operated From Cab; 5 Axles & Over; Belly Dump; End Dump; Articulated Dump; Heavy Duty Equipment; Low Boy; & Truck Mechanic

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TEAM0436-002 05/01/2019

CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 28.40	16.95
GROUP 2	$ 28.90	16.95

GROUP 1: Straight & Dump, Straight Fuel

GROUP 2: Semi Fuel, Semi Tractor, Euclids, Darts, Tank, Asphalt Spreaders, Low Boys, Carry-All, Tourna-Rockers, Hi-Lifts, Extra Long Trailers, Semi-Pole Trailers, Double Hook-Up Tractor Trailers including Team Track & Railroad Siding, Semi-Tractor & Tri-Axle Trailer, Tandem Tractor & Tandem Trailer, Tag Along Trailer, Expandable Trailer or Towing Requiring Road Permits, Ready-Mix (Agitator or Non-Agitator), Bulk Concrete Driver, Dry Batch Truck, Articulated End Dump

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WELDERS - Receive rate prescribed for craft performing

operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number

where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board

U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

SECTION 01 1100

SUMMARY OF WORK

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 PROJECT DESCRIPTION

A. The project consists of the construction of a membrane softening addition to the existing Richard A. Renneker Water Treatment Plant to treat 13.7 MGD (expandable to 22.0 MGD) of groundwater. Improvements include a new nanofiltration softening building complete with NF softening equipment, pumps, process piping, valves, deasifiers, chemical feed systems, and all associated architectural, structural, HVAC, plumbing, electrical, instrumentation and controls work shown on the plans.

B. The existing water treatment plant and wells must be kept in operation during construction. Temporary outages are permitted to allow for improvements but must have adequate notice provided to the Owner and must be kept to minimum duration.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The work of any one trade, Contractor or Subcontractor shall not be limited to the work listed in a Section under "Project Description". Such listings are intended as general guides to the contents of a Section, and not as a defined scope of work. Unless otherwise indicated, provide and pay for all labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, test equipment, testing and other facilities and services necessary for the proper execution and completion of the work, whether temporary or permanent, and whether or not incorporated or to be incorporated in the work.

1.4 WORK SEQUENCE

A. Out-of-Sequence Work
   1. The work includes any out-of-sequence work required to meet job progress, such as work made necessary by removal of construction plant or temporary facilities, work necessitated by the special construction phasing requirements of the Project, or work caused or interrupted by the Owner's operations.
   2. Certain work may be required in order to provide occupancy of the Project prior to its final completion. Such work may not necessarily be in sequence with other work of the Contractor.
   3. Work omitted because of construction schedules, interference with construction facilities, sequence of operations, or job conditions shall be completed as set forth in the Contract Documents.
   4. In the event of out-of-sequence work, the Contractor shall perform his work in the areas designated and shall have no claims against Owner and does hereby release Owner from any claims for damages or extra cost by reason of any such requirements.
   5. Perform all such work at no extra cost to the Owner.

1.5 CONTRACTOR USE OF PREMISES

A. Access: At all times, provide the Engineer and Owner easy and safe access to the work wherever it is in preparation and progress. Provide such access so Engineer may perform his functions.

B. Use of Site
   1. Confine operations at the site to areas permitted by law, ordinances, permits and the Contract Documents and do not unreasonably encumber the Site with any materials or equipment.

C. Environmental Requirements: The following requirements are in addition to all applicable laws and regulations:
   1. No burning will be permitted on the Site.
   2. Control dust by water sprinkling, temporary enclosures, or other methods acceptable to the Owner. Comply with governing regulations.
   3. Provide proper ventilation for enclosed spaces during construction.
   4. In the generation of temporary power or heat, or in the operation of equipment of any kind, do not use fuels which leave deposits on building surfaces.

D. Interruption of Owner Activities
   1. Owner will continue operations of existing facilities at the Site during progress of the work.
   2. Maintain continuous service of utilities and telephone at all times.
   3. Do not work in occupied areas if not required.
   4. If it becomes necessary to temporarily disrupt Owner's operations or have access to occupied areas, make arrangements with Owner for proper timing.
      a. No additional compensation shall be allowed for shutdowns even though overtime work may be required.
      b. Contractor shall provide a minimum of 48 hours notice to Owner for shutdowns to be scheduled. Owner has the right to not allow a scheduled shut-down if conditions are not favorable.

E. Owner's Rules
   1. Conform at all times to Owner's requirements for protection of plant, materials, equipment and employees.
   2. Use designated routes of access through existing facilities and keep such routes clean and free of obstruction at all times.
   3. Do not use toilets and other functioning facilities in use by Owner.
   4. Do not discard trash, rubbish, cigarettes, or other items on Owner facilities.
   5. Do not pound, drill, use explosive fasteners, or perform other noisy operations, except within time periods coordinated with Owner in advance.
   6. Valve Operations: All existing valves shall be operated by the OWNER’S personnel only. Scheduling of valve operations shall be made with the OWNER at least two (2) days in advance of the actual valve operation.

1.6 OWNER FURNISHED PRODUCTS

A. Documents Furnished: Owner will furnish the following sets of Project Drawings and Manuals free of charge. Additional sets may be purchased by paying the cost of printing the Drawings and Project Manual.

1. Contractor: Three (3) full-size sets of drawings, (2) half-size sets of drawings, (3) sets of specifications, and one (1) CD with PDF files of all drawings and specifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 1100

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SECTION 01 2100

ALLOWANCES

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 DESCRIPTION OF WORK

A. The Contractor shall review the Allowance List for items affecting his portion of the Work. Include in the Contract Sum the amount listed.

B. Items covered by these Allowances shall be supplied by such persons as the Owner may direct, but the Contractor will not be required to deal with parties against whom the Contractor makes a reasonable objection.

C. Unless otherwise provided in the Contract Documents, these Allowances shall cover the cost to the Contractor of the materials and equipment required by the Allowance delivered at the Site, and all applicable taxes. Submit invoices for Allowance items.

D. The Contractor's costs for unloading and handling on the Site, labor, installation costs, overhead, profit, and other expenses contemplated shall be included in the Contract Sum, and not in the Allowance.

E. Whenever the cost is more than or less than the Allowance, the Contract Sum shall be adjusted accordingly by Change Order. Where there is an increase or decrease in quantity, the amount of any Change Order will include changes, if any, in handling costs on the site, labor, installation costs, overhead, profit, and other expenses.

1.3 CASH ALLOWANCES

A. Tools and Maintenance Equipment: $15,000
   1. This allowance shall be full compensation for all tools and maintenance equipment (above and beyond that which is specified) to be used during construction.

B. Office Furniture: $10,000
   1. This allowance shall be full compensation for all furniture (above and beyond that which is specified) to be used at RARWTP, selected by the Engineer and/or Owner during the shop drawing review process.

C. Materials Testing: $40,000
   1. This allowance shall be full compensation for only the reimbursement of soils and concrete testing. The Contractor shall be compensated for the actual invoice amount from those performing the Materials Testing.

D. Local Utility Company: $40,000
   1. This allowance shall be full compensation for only the Local Utility Company’s scope of work necessary to provide new electrical service to the project site as shown on the

drawings and as specified along with relocation of existing utilities as needed for the new work to be performed. The Contractor shall be compensated for the actual invoice amount from the Local Utility Compay for this work. Contact Greg Finley at (513) 287-1104 for coordination with Duke Energy.

E. Trailer Mounted Valve Operator: $15,000
   1. This allowance shall be full compensation for acquiring two (2) trailer mounted valve operators to be provided to the Owner.

F. Security System: $70,000
   1. This allowance shall be full compensation for the security system scope of work to provide new equipment relative to the NF Building and West access gate and also for modifications of existing buildings' systems as shown on the drawings and as specified. New equipment installation shall be provided under the Contractor's bid outside of this allowance. Modifications to existing buildings' systems shall be provided by the security system supplier under this allowance. The Contractor shall be compensated for the actual invoice amount from the security system supplier for this work.

G. NFC Cleanouts and CCTV: $45,000
   1. This allowance shall be full compensation for the installation of two (2) cleanouts on RARWTP's existing NFC discharge line and CCTV of the line. Location of cleanouts to be approved by the Engineer and/or Owner during installation. CCTV data to be provided to the Owner.

H. Lab Equipment: $5,000
   1. This allowance shall be full compensation for all laboratory equipment and accessory improvements (above and beyond that which is specified) to be used at the RARWTP lab, selected by the Engineer and/or Owner during the shop drawing review process.

I. SCADA: $20,000
   1. This allowance shall be full compensation for only the SCADA Allowance as specified in Section 40 9443.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 2100

SECTION 01 2300

ALTERNATES

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 DESCRIPTION OF WORK

A. Each Contractor shall read the descriptions of each Alternate listed and determine the extent to which his work is affected.

B. Submit for each Alternate, in the spaces provided on the Bid Form, an amount to be added to or deducted from the Base Bid.

C. Refer to Instructions to Bidders for a description of how Alternate prices affect award of the Contract.

D. The description of the work as listed herein is not intended to be a complete specification of all work included. Conform to the Technical Sections and the Drawings for requirements.

E. Each Alternate shall be complete in every detail and in conformance with the Contract Documents.

F. Include in the Alternate price the cost of all work including modification of other related items, overhead and profit.

1.3 LIST OF ALTERNATES

A. No Alternates.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 2300

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SECTION 01 2600

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Sections:
1. Division 01, Section “Allowances” for procedural requirements for handling and processing allowances.
2. Division 01, Section "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
1. Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change
2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Engineer.
1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the

proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
5. Comply with requirements in Division 00 Section "General Conditions" if the proposed change requires substitution of one product or system for product or system specified.

C. Proposal Request Form: For Change Order proposals, use forms provided by Owner. Sample copies are included at end of this Section.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Work Change Directive: Engineer may issue a Work Change Directive. Work Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. Work Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.
   1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 2600

SECTION 01 2973

SCHEDULE OF VALUES

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 SCOPE

A. This Section modifies the requirements of the General Conditions relating to the submittal of a Schedule of Values.

1.3 PURPOSE

A. It is necessary to breakdown the lump sum prices (either total contract or selected items) for contract administration purposes, i.e., scheduling and payment.

B. The items in the Schedule of Values shall be included in any schedule presented as a part of this Contract as applicable, and shall be included as the basis for determining periodic payments to the Contractor.

1.4 SCHEDULE PREPARATION

A. The Schedule of Values shall be prepared by the Contractor and submitted to the Engineer for approval. The Schedule of Values must be approved prior to the submittal of the first periodic payment request.

B. The Schedule of Values must be detailed enough to perform the intended function, but not so complicated as to make it cumbersome to work with. Depending on the project or the specific item, the following comments are offered for consideration:
   1. Mobilization and demobilization can be included.
   2. Bonds and insurance may be a separate item.
   3. Include reinforcing with the concrete.
   4. As much as possible, follow the specification titles as subjects.
   5. Separate similar items that will be installed at different times.
   6. Include auxiliary items with the main item, i.e., include motors with pumps, actuators with valves, etc.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 2973

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SECTION 01 2986.13

AFFIDAVIT AND WAIVER OF LIEN
(PARTIAL OR PERIODIC PAYMENT)

STATE OF _____

COUNTY OF _____

(This document has important legal consequences: Consultation with an attorney is encouraged with respect to its completion or modification.)

_____ being first duly sworn says that he is
(Individual)
_____of _____
(Authorized Officer)
(hereinafter referred to as the "Company") and is familiar with the following facts stated herein:

1. The Company performed services, labor, and/or furnished material, machinery, equipment, and fuel (hereinafter referred to as "Work") on a Project for the construction of certain buildings and/or improvements known as _____ on property owned by _____ (hereinafter referred to as "Owner"), and located at _____ _____ (hereinafter called the "Property").

2. The Company has a contract with and has provided Work for _____ _____ as a _____
(Name of Owner, Contractor, Subcontractor) (Contractor, Subcontractor, Material Supplier)

3. All laborers, materialmen, and Subcontractors of the Company have been paid for Work furnished by them to the Company for the Project to the full extent that sums were due to said parties and for which the Company has previously received payment for Work so furnished by said parties.

4. The current invoice amount from the Company to _____ _____ is _____
(Name of Owner, Contractor, Subcontractor)
_____ Dollars ($_____)

The balance currently due and unpaid to the Company (including the current invoice amount) is

_____ Dollars ($_____)

Without waiving for mechanic's lien or other purposes the priority of the date that the Company first commenced performing Work for the Project, the Company agrees that upon the payment to it of said current invoice amount, the Company hereby waives and releases only to the extent of said current invoice amount (a) all liens and lien claims and rights against the property and funds of the Owner, and (b) all claims against the Owner with respect to amounts due from the Owner for the Company.

5. The Company represents that it is not aware of any mechanic's lien having been filed by or presently threatened to be filed by any party having provided Work for the Company against the Property or funds of the Owner.

6. The total amount invoiced to date (including the current invoice amount) by the Company is

_____ Dollars ($_____)

_____
Individual's Signature

Sworn to before me and subscribed in my presence this _____ day of _____20 ____

_____
Notary Public

END OF SECTION 01 2986.13

SECTION 01 2986.16

AFFIDAVIT AND WAIVER OF LIEN
(FINAL PAYMENT)

STATE OF _____

COUNTY OF _____

(This document has important legal consequences: Consultation with an attorney is encouraged with respect to its completion or modification.)

_____ being first duly sworn says that he is
(Individual)
_____of _____
(Authorized Officer)
(hereinafter referred to as the "Company") and is familiar with the following facts stated herein:

1. The Company performed services, labor, and/or furnished material, machinery, equipment, and fuel (hereinafter referred to as "Work") on a Project for the construction of certain buildings and/or improvements known as _____ on property owned by _____ (hereinafter referred to as "Owner"), and located at _____ _____ (hereinafter called the "Property").

2. The Company has a contract with and has provided Work for _____ _____ as a _____
(Name of Owner, Contractor, Subcontractor) (Contractor, Subcontractor, Material Supplier)

3. All laborers, materialmen, and Subcontractors of the Company have been paid for Work furnished by them to the Company for the Project to the full extent that sums were due to said parties and for which the Company has previously received payment for Work so furnished by said parties.

4. The current invoice amount from the Company to _____ _____ is _____
(Name of Owner, Contractor, Subcontractor)
_____ Dollars ($_____)

The balance currently due and unpaid to the Company (including the current invoice amount) is

_____ Dollars ($_____)

Without waiving for mechanic's lien or other purposes the priority of the date that the Company first commenced performing Work for the Project, the Company agrees that upon the payment to it of said current invoice amount, the Company hereby waives and releases only to the extent of said current invoice amount (a) all liens and lien claims and rights against the property and funds of the Owner, and (b) all claims against the Owner with respect to amounts due from the Owner for the Company.

5. The Company represents that it is not aware of any mechanic's lien having been filed by or presently threatened to be filed by any party having provided Work for the Company against the Property or funds of the Owner.

6. The total amount invoiced to date (including the current invoice amount) by the Company is

_____ Dollars ($_____)

_____
Individual's Signature

Sworn to before me and subscribed in my presence this _____ day of _____20 ____

_____
Notary Public

END OF SECTION 01 2986.16

SECTION 01 3113

COORDINATION

PART 1 GENERAL

1.1 REFERENCES

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 PROJECT COORDINATION

A. This project is a single-prime contract. The General Contractor is responsible for coordination between any sub to the General Contractor (including but not limited to electrical, HVAC, plumbing, system integration, painting, etc.). This includes providing information and work as required so as not to delay other contractors or the project.

B. Failure to comply with these provisions may result in the Owner withholding payment to cover damages to the other contractors who have a contract with the Owner and/or could be cause for termination of the contract.

C. Cooperation and coordination includes, but is not necessarily limited to scheduling, attending meetings, preparation and submitted of coordination drawings in a timely manner, providing temporary facilities, cleanup, and other such items.

1.3 WORK SEQUENCING AND PLANT SHUT-DOWN

A. The existing water treatment plant is to remain operational during Construction. Temporary shut-downs are permitted to allow for operations such as tying into water lines or electrical outages, but must be coordinated with the Owner and Engineer.

B. Sequence of work shall be coordinated with the Engineer prior to work commencement if temporary plant-shut downs are required. Such work requiring sequence approval includes, but is not limited to:
   1. Any shut-down of raw water delivered from the well-field.
   2. Any shut-down of treated water delivered to the clearwells.
      a. The longest outage acceptable for the required tie-ins to the gravity filter effluent and existing clearwells is eight (8) hours. This work must be completed between November 1 and April 30. If more than one outage is required, sufficient time must be allowed for clearwell levels to return to normal levels before the next outage.
   3. Any shut-down of finished water delivered to distribution system.
      a. The longest outage acceptable for the required tie-ins within the high service pump building is eight (8) hours. This work must be completed between November 1 and April 30. If more than one outage is required, sufficient time must be allowed for distribution system tank levels to return to normal levels before the next outage.
   4. Work in existing chemical feed building.
      a. The longest outage acceptable for existing chemical feed facilities is eight (8) hours. This work must be completed between November 1 and April 30. All

existing chemical must be capable of being fed continuously and automatically (i.e. tied into SCADA system) while renovations are ocuring in this building.

5. Any shut-down of effluent from the red water filters.
    a. The longest acceptable outage for the required tie-ins to the existing red water filter system is sixteen (16) hours. If more than one outage is required, sufficient time must be allowed for backwashing before the next outage.
6. Any electrical outages.
    a. The longest electrical outage acceptable is eight (8) hours. If more than one outage is required, sufficient time must be allowed for clearwell and distribution system tank levels to return to normal levels before the next outage.

1.4 CUTTING AND PATCHING

A. Cutting and Patching
1. Cutting of new and existing work, including demolition of portions of structures (i.e., to install an item in an existing wall or floor), shall be performed by the Contractor or Subcontractor requiring access.
2. Openings in new work which can be pre-planned by the Contractor requiring the opening shall be built into the work by the proper trade for each material under his Contract. It is the responsibility of the Contractor requiring such openings or requiring the placement of built-in items, to coordinate the work with the proper trade for each material, sufficiently in advance for the work to be accomplished in the proper sequence and without delay, or pay the costs caused by the delay or for extra work required.
3. Do not damage or endanger any portion of the work of the Contract, of the Owner, or of any separate Contractors by cutting, patching or otherwise altering any such work, or by excavation.
4. Do not cut or otherwise alter the work of the Owner or any separate Contractor except with the written consent of the Owner and of such separate Contractor. Do not unreasonably withhold from the Owner or any separate Contractor, consent for cutting or otherwise altering the work.
5. Do not cut, weld to, drill, remove or otherwise alter any structural member, whether new or existing, without the written consent of Engineer, unless such condition is indicated in detail on the Drawings and reinforcing of members affected or new members to compensate for such cutting, drilling, removals or other alteration are indicated.

B. General Patching Requirements
1. Patching work shall be performed by the proper trade for each material to be patched.
2. Patch all materials, including finish materials, damaged in the performance of work under this Contract.
3. Where walls, partitions and ceilings are required to have a smoke or fire rating, they must be continuous through concealed spaces and sealed tightly against any penetrations of pipes, ducts, conduits, or other building components.
    a. Patching shall be required of any cracks, holes or defects whether existing or resulting from the work of this or any other Contract in this Project to achieve the required smoke or fire rating.
    b. Patching shall be performed to restore and to maintain the integrity of floor/ceiling assemblies and roof/ceiling assemblies that are required to have a fire rating.
4. Workmanship: If the wall or ceiling is painted, the final 2 coats of paint shall be applied to the entire wall, corner to corner.
5. Responsibility for patching and payment therefore shall be on the following basis:

a. Patching after cutting by a trade requiring access into construction shall be paid for by the trade requiring access.
b. Holes or other openings left by installation of mechanical or electrical items or by installation of cabinetwork or other equipment shall be paid for by the trade installing such item.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 3113

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SECTION 01 3119

PROJECT MEETINGS

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 PRE-BID MEETING

A. Refer to Division 00, Section “Advertisement for Bids” for any information regarding the pre-bid meeting.

1.3 PRE-CONSTRUCTION MEEITNG

A. A pre-construction meeting will be scheduled by the Owner and Engineer after the award of contract.

B. The agenda will be prepared by the Owner. Items to be discussed will include those sections of the specifications preceding Division 02.

C. Items to be discussed will include those sections of the specifications preceding Division 02. The Engineer will prepare the agenda from the following items:
   1. Discussion of construction schedules
   2. Critical work sequencing
   3. Major equipment deliveries and priorities
   4. Project Coordination
      a. Designation of responsible personnel
   5. Procedures and process of:
      a. Field decisions
      b. Proposal requests
      c. Submittals
      d. Change orders
      e. Applications for payment
   6. Adequacy of distribution of Contract Documents
   7. Procedures for maintaining Record Documents
   8. Use of existing Premises
      a. Office, work, and storage areas
      b. Owner’s requirements
   9. Construction facilities, controls, and construction aids
   10. Temporary utilities
   11. Safety and first aid procedures
   12. Security procedures
   13. Housekeeping procedures

D. The Owner’s representative, the Engineer, and successful bidders shall attend. The Engineer’s Resident Project Representative and the Contractor’s Superintendent shall attend. Other interested personnel may also attend.

E. The meeting will be chaired by the Engineer who will take and distribute minutes.

1.4 PROGRESS MEETINGS

A. The Contractor shall, at a time and place approved by the Engineer, hold job meetings to coordinate the work and discuss problems that may arise concerning proper timing and execution of the work.
   1. Additional meetings may be called by the Owner, Engineer or Contractor as the need arises.
   2. Responsible representatives of the Contractors, Owner, and Engineer shall attend these meetings. Subcontractors may occasionally be asked to attend.
   3. Engineer shall preside and take minutes of each entire meeting and reproduce and distribute such minutes to all parties concerned.
   4. Suggested Agenda:
      a. Review and approval of minutes of previous meeting
      b. Review of work progress since previous meeting
      c. Field observations, problems, conflicts
      d. Problems which impede construction schedule
      e. Review of off-site fabrication, delivery schedules
      f. Corrective measures and procedures to regain projected schedule
      g. Revisions to Construction Schedule
      h. Progress, schedule, during succeeding work period
      i. Coordination of schedules
      j. Review submittal schedules; expedite as required
      k. Maintenance of quality standards
      l. Pending changes and substitutions
      m. Review proposed changes for:
         1) Effect on construction schedule and on completion date
         2) Effect on other contracts of the Project
      n. Other business

B. Responsible representatives of the Contractors, Owner, and Engineer shall attend these meetings.

C. Each Contractor shall be responsible for notifying his subcontractors of the time and place of job meetings if he wishes them present, or if their presence is requested of him by the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 3119

SECTION 01 3300

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 GENERAL

A. All submittals shall be made to the Engineer unless specifically noted otherwise or unless instructed in writing by the Owner.

B. Submit a complete list of required submittals.

C. Receive, check, approve as required, and submit all items listed herein by the time indicated, accompanied by a transmittal letter using the form attached at the end of this Section.

D. Keep an accurate record of the date of submittal and the date received on the Project.

E. Contractor shall supply all AIA forms. (One source of supply is the local AIA Chapter office.) The Engineer will supply a copy of all other forms.

F. Following is a general list of required submittals and the time frame for submittal.
   1. Within 30 Days after Contract Signing
      a. Progress schedule.
      b. Submittal schedule.
   2. Prior to First Progress Payment
      a. Progress Schedule.
      b. Submittal Schedule.
      c. Application and Certificate for Payment.
      d. Schedule of Values.
      e. Subcontractor and Material Lists.
   3. With Each Progress Payment.
      a. Affidavit and Waiver of Lien (see attached form) from each Contractor and sub-contractor.
      b. Submittal Schedule.
      c. Schedule of Values.
   4. As Work Progresses
      a. Monthly updated Progress Schedule.
      b. Wage Rate and Payroll Certificates.
      c. Notice of Furnishings.
      d. Materials Certifications.
      e. Test Reports.
      f. Shop Drawings.
      g. Maintenance Instructions.
      h. Operating Instructions.
      i. Product Data.
      j. Samples.
      k. Reference Submittals.
      l. Progress Photographs.
      m. Special Guaranties and Warranties.

n. Updated Subcontractor List.

5. With Request for Final Payment
   a. As-Built Drawings.
   b. Final Affidavits and Waivers of Lien (see attached form).
   c. Complete package of Shop Drawings and Product Data conforming reproducibles.
   d. Final Photographs.
   e. Keys and Keying Schedule.
   f. Certificate of Inspection.
   g. Certificate of Occupancy.

1.2 PROGRESS SCHEDULES

A. Preliminary Construction Schedule

1. At fourteen calendar days following written Notice to Proceed, a Contract Milestone date has been established which is the Contractor's submittal to the Engineer for review and approval of an electronic PDF of a bar-chart schedule covering the first 45 calendar days of work to be performed, while the Detailed Construction Network is being prepared. A copy will be returned to the Owner, Field Representative, and each Contractor.
2. The Contractor shall submit to the Engineer for review and approval, with the Preliminary Construction Schedule, a detailed breakdown of the costs for all work activities identified in the schedule. The cost for each work Activity shall include mobilization, materials, labor, equipment, overhead, and profit. The Contractor will include the cost projections as part of the CPM Schedule or as a separate document that corresponds to the CPM Schedule. Cost breakdown must be consistent with the Pay Items of the base bid schedule. After review, any necessary revision, and approval, this cost breakdown will be utilized as the basis for review of progress payment estimates during the initial 45 days of the Contract prior to use of the approved Schedule of Values.
3. The Contractor shall revise the schedule and cost breakdown according to the comments received from the Engineer and submit an electronic PDF of the revised schedule and cost breakdown to the Engineer within ten calendar days after receipt. The reviewed schedule will then be considered the "Approved 45 Day Preliminary Construction Schedule."

B. Detailed Construction Network

1. The Detailed Construction Network in precedence format shall be a computer-generated and computer-drawn schedule analysis.
2. A Detailed Construction Network represents the Contractor's best judgment of how it shall prosecute and complete the work in compliance with the Contract Milestone Dates and any other Specific Dates stipulated in the Contract Documents.
3. The identity and duration of all Activities to be included in this Construction Plan. Activities shall meet the following criteria:
   a. Activities shall be numbered, and their descriptions shall be clear and concise. Where applicable, descriptions shall include quantities of work.
   b. Activities shall be coded with sufficient detail to allow identification of the Activity as to type of work, work responsibility, interfacing of the activity with other contracts, and any other coding necessary to accurately describe the work Activity. All Activities associated with the preparation, submittal and approval of information required by the Engineer shall be coded so they may be readily identified.
   c. Resource requirements (manhours by craft, material, equipment, services, etc.) shall be described for each Activity, in the resources dialog box.

d. The quantity and cost component for each Activity shall be provided. The sum of the Activity cost components shall equal the Contract Price. If the Contract calls for pay items, the Activity shall also be coded to allow identification with its respective pay item(s). Fabrication of materials and/or equipment shall be described in a separate Activity. The cost component of any fabrication Activity shall be zero.

4. The identity of long lead items and delivery dates of all major pieces of equipment or materials.
5. The identity of any potential problems or constraints related to the implementation of the overall construction plan.
6. All Activities included in the Preliminary Construction Network shall be included in the Detailed Construction Network.
7. The plot of the Detailed Construction Network shall:
   a. Show the interdependencies of the work Activities and the major points of interface or interrelation with the activities of others, including Specific Dates for completion.
   b. Indicate conformance with the specific interim Milestone Dates specified in the Contract Documents.
   c. Include the description and quantity of work, by Activity.
   d. Allow for the time required for engineering, preparation, submission, and approval of submittals (including O & M Instructions), manufacturing, delivery, and installation of Contractor-furnished permanent plant materials.
   e. Indicate required dates of delivery of Owner-furnished material and equipment. (If applicable).
   f. Delineate the critical Path (or Paths).
   g. Indicate all erection and installation Activities.
   h. Indicate all testing of equipment and materials.
   i. Indicate startup, operational demonstration, and commissioning Activities.
   j. Be furnished in color, with necessary legend sheets, and on electronic 22-inch x 34-inch sheets.
8. The Detailed Construction Network shall indicate late completion date for the project that is no later than the Project's required date for final completion. All Activity durations shall be given in working days. The Network shall also indicate each of the following:
   a. Interfaces with the work of outside entities, e.g., utilities, power, any separate contractors.
   b. Description of Activity, including Activity numbers.
   c. Estimated duration for each Activity.
   d. Early start date for each Activity.
   e. Late start date for each Activity.
   f. Early finish date for each Activity.
   g. Late finish date for each Activity.
   h. Float available for each path of Activities.
   i. Actual start date for each Activity begun.
   j. Actual finish date for each Activity completed.
   k. The Critical Path for the project, with said path of Activities being clearly and easily recognizable on the time-scaled network diagram. The relationship between all non-critical Activities and Activities on the Critical Path shall be clearly shown on the plot of Detailed Construction Network by symbol.
   l. The dollar value and quantity of work for each Activity, corresponding with the Schedule of Values.

m. The responsibility, by Contractor, Subcontractor, or Supplier, for each Activity or portion thereof.
n. The percentage complete for each Activity in progress or completed.

C. The Contractor shall submit with the Detailed Construction Network, an electronic PDF a narrative description indicating anticipated allocation of the following resources and work shifts to be utilized on the project:
1. Labor resources by each craft, representatives of the equipment manufacturers, and all other personnel that have been retained by the Contractor.
2. Equipment resources.
3. Whether work will be performed on a one, two, or three-shift basis.
4. The Contractors specific understanding of the effects of seasonal weather conditions on the scheduled work, and the anticipated measures the Contractor and all sub-contractors will exercise to accommodate the known local weather conditions.

D. It is to be expressly understood and agreed to by the Contractor that the schedule is an estimate to be revised from time-to-time as progress proceeds. The Owner does not guarantee that the Contractor can start work activities on the "early start" or "late start" dates, nor complete work activities on the "early finish" or "late finish" date as shown in the schedule, or as same may be updated or revised. The Owner or Engineer does not guarantee that Contractor can proceed at all times in the sequence established by said schedule.

E. Within 21 calendar days following Notice to Proceed, the Contractor shall also submit an electronic PDF of its proposed Schedule of Values (using the breakdown of the computer listing of Activities) to the Engineer. The Schedule of Values shall allocate a dollar value (cost) for each Activity of the Detailed Construction Network. Each Activity cost allocation shall include labor, equipment, and material costs, including a pro rata contribution for overhead and profit. The sum of all Activity costs shall be equal to the total Contract Sum. Each Activity cost shall be coded by the Contractor, to show which subcontractor is responsible for performing the work so that subtotals for each coded activity of the work can be prepared. The Contract Pay Item for each Activity shall be indicated. The sum of costs for each Pay Item shall equal the value submitted with the Contractor's proposal.

F. The Engineer will review the Contractor's Detailed Construction Network and Schedule of Values. The review of the Detailed Construction Network, including logic diagrams and computer generated mathematical analysis will be for compatibility with the required Project Construction and Commissioning Schedule. The review of the Schedule of Values will verify that the Schedule of Values shall, in the best judgement of the Contractor, and the Engineer, represent a fair, and equitable dollar value for each Activity on the Detailed Construction Network. The Contractor shall revise its Detailed Construction Network and Schedule of Values as required to support the Project Construction and shall resubmit them to the Engineer within ten calendar days for re-review. The Contractor's resubmittal shall include the following:
1. Plot of the Detailed Construction Network (electronic PDF).
2. Computer disks of the Detailed Construction Network (1 set).
3. Schedule of Values (electronic PDF).
4. Computer listings/supporting data (electronic PDF).

G. Within 10 calendar days following submission of an acceptable Detailed Construction Network and Schedule of Values, the Engineer will return an electronic PDF to the Contractor. The Contractor shall review these returned items and within five calendar days following the receipt from the Engineer signify its agreement by signing one copy of each document and returning it

to the Engineer. Approval shall be signified by the Engineer also signing the copies of the documents which were signed and returned by the Contractor. The Contractor's approved Detailed Construction Network and Schedule of Values shall then be the documents which the Contractor shall use in planning, coordinating, and executing the work (including all activities of Subcontractors, equipment vendors and suppliers) and shall be the basis for evaluating the progress of the work and supporting requests for payment, subject to such revisions made in such schedule as are provided for in the Contract Documents.

H. Approval by the Engineer of the Contractor's Detailed Construction Network is advisory only and shall not relieve the Contractor of the responsibility for accomplishing the work within each and every Contract-required Milestone and Completion date. Omissions and errors in the approved Detailed Construction Network shall not excuse performance which is not in compliance with the Contract. Approval by the Engineer in no way makes the Owner, Engineer an insurer of the Detailed Construction Network's success or liable for resultant time or cost overruns attributable to its shortcomings. The Owner hereby disclaims any obligation or liability by reason of the Owner, or Engineer's approval of or acquiescence to the Detailed Construction Network.

I. Recovery Schedule

1. If certain activities shown on the Contractor's Detailed Construction Network fall behind schedule, to the extent that any of the mandatory specific or milestone or completion dates are in jeopardy, the Contractor shall prepare and submit to the Engineer a Supplementary Recovery Schedule, in a form and detail appropriate to the need, which explains and displays how the Contractor intends to reschedule those activities, in order to regain compliance with the Detailed Construction Network during the immediate subsequent pay period. Both the preparation of the Recovery Schedule, and all necessary acts under that Recovery Schedule required to recover compliance with the mandatory dates, shall be at no additional cost to the Owner.
2. The Contractor shall do the following after determination of the requirement for a Recovery Schedule:
    a. Within three calendar days, the Contractor shall prepare and complete the Recovery Schedule. The Contractor and major Subcontractors shall provide the Engineer with such information as is required to assist in review of the Recovery Schedule. The Recovery Schedule shall represent the Contractor's best judgment as to how it shall reorganize its work so that it may return to the Detailed Construction Network within the immediate subsequent pay period. The Recovery Schedule shall be prepared to a similar level of detail as the Detailed Construction Network and shall have a maximum duration of one month which shall coincide with the pay period.
    b. Within five calendar days, the Contractor shall participate in a conference with the Engineer to review and evaluate the Recovery Schedule. Any revisions necessary as a result of this review shall be resubmitted by the Contractor for approval within two calendar days of the conference. The approved Recovery Schedule shall then become the Schedule which the Contractor shall use in planning, coordinating, and executing the work (including all activities of subcontractors, equipment vendors, and suppliers) for its one month duration, to regain compliance with the Detailed Construction Network.
    c. Five calendar days prior to the expiration of the Recovery Schedule, the Engineer and the Contractor will meet at the job site for the monthly update and to evaluate the effectiveness of the Recovery Schedule, and shall determine whether the

Contractor has regained compliance with the Detailed Construction Network. At the direction of the Engineer, one of the following will occur:

1) If, in the opinion of the Engineer, the Contractor is still behind schedule, the Contractor shall prepare another Recovery Schedule, at the Contractor's expense, pursuant with this Paragraph, which will take effect during the immediate subsequent pay period. This schedule shall be prepared under the immediate review of the Engineer.
2) If, in the opinion of the Engineer, the Contractor has sufficiently regained compliance with the Detailed Construction Network, the use of the Detailed Construction Network will be resumed.

J. Requested Time Adjustment Schedule

1. The updated Detailed Construction Network and accompanying reports submitted by the Contractor shall not show a completion date later than the stipulated completion date, subject to any time extensions approved by the Owner. If the Contractor believes it is entitled to an extension of the Contract Time under the provisions of the Contract Documents, the Contractor shall submit to the Engineer, with each progress payment update, a separate schedule analysis (entitled "Requested Time Adjustment Schedule") indicating suggested adjustments in the Contract Time which should, in the opinion of the Contractor, be made in accordance with the Contract Documents for time adjustments, which are due to changes, delays, or conditions occurring during the past month or previously, or which are expected or contemplated by the Contractor (whether such conditions are excusable under the Contract or are alleged to be due to Contractor or Owner fault). This separate schedule, if submitted, shall be a computer-generated and computer-drawn schedule analysis, and shall be accompanied by a formal time extension request, as required by the Contract and a detailed narrative justifying the time extension requested.
2. The time extension request shall include forecasts of the actual Project Completion Date, completion of any sequences of Activities required by the Owner, and a forecast of the resultant actual achievement of Milestones listed in the Contract.
3. To the extent any time extension requests are pending at the time of any update of the Construction Schedule, the "Requested Time Adjustment Schedule" shall also be updated to reflect any adjustments made by Contractor in the logic, sequence, or duration of any Activities, any time extensions previously granted by the Owner, and to reflect actual or expected progress, in order that the "Requested Time Adjustment Schedule" shall clearly and accurately reflect the Contractor's actual intention and proposed time adjustments.
4. Neither the Engineer or the Owner have any obligation to consider any time extension request unless the requirements of the Contract Documents are complied with. The Owner shall not be responsible or liable to the Contractor for any constructive acceleration due to failure of the Owner to grant time extensions. The Contractor's failure to perform in accordance with the approved Detailed Construction Network shall not be excused, nor be chargeable to the Owner, simply because the Contractor has submitted time extension requests or the "Requested Time Adjustment Schedule."

K. Each request for payment submitted to Engineer for approval shall be accompanied by the individual Contractor's Progress Schedule. The Progress Schedule shall be that schedule required above. The schedule accompanying the request for payment shall indicate actual progress compared to that anticipated on each approved Contractor's Progress Schedule. If actual performance does not meet the performance as shown on the approved schedule in total or on individual line items, revise and submit evidence as to what efforts the individual Contractor will take to meet the approved schedule. Failure to submit the Progress Schedule

with each request for payment shall be cause for not processing the request for payment until receipt of schedule as required above.

1.3 PROGRESS REPORTS

A. Each Prime Contractor shall provide the Engineer with a detailed progress report showing work completed the last month. Provide at each monthly progress meeting.

1.4 SHOP DRAWINGS, PRODUCT DATA, SAMPLES AND REFERENCE SUBMITTALS

A. Definitions
   1. Shop Drawings are drawings, diagrams, schedules and other data specially prepared for the work by the Contractor or any Subcontractor to illustrate some portion of the work.
   2. Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate a material, product or system for some portion of the work.
   3. Samples are physical examples which illustrate materials, equipment or workmanship and establish standards by which the work will be judged.
   4. Reference Submittals are any technical data or submittals listed in the technical sections of the Specifications, under Reference Submittals including but not limited to test reports, surveys, special guaranties and warranties, maintenance and operating instructions, extra stock, installers' certification, material certification, and calculations.
   5. Shop Drawings, Product Data, Samples, and Reference Submittals are not to be construed as Contract Documents, they are to be used by the Contractor for his convenience only.

B. General Requirements
   1. There shall be no substitutions for specified products, equipment, or systems except as allowed in Division 01 Section “Product Requirements”.
   2. Shop Drawings and Product Data are solely the responsibility of the Contractor, and shall be checked by him. Engineer and Owner take no responsibility whatsoever for such documents submitted for review.

C. Shop Drawings
   1. Prepare project specific information, drawn accurately and to scale. Do not base shop drawings on reproductions of the contract documents or standard printed data, unless otherwise permitted.
   2. Only those Shop Drawings and Product Data will be reviewed:
      a. Where details of fabrication, installation or attachment are required to supplement the Contract Documents.
      b. Where there are deviations from the Contract Documents for any reason. (This procedure is not for the purpose of reviewing substitutions.)
      c. Where further documentation is required to show the proposed product or system is in conformance to every requirement of a performance Specification.
      d. Where listed under Submittals in each technical section.
   3. Shop Drawings and Product Data shall be submitted in sufficient detail to permit the Reviewer to review:
      a. That product or system is as specified or shown.
      b. Details of fabrication, installation or attachment.
      c. For complete conformance to each requirement of performance Specifications, line item by line item.

4. Shop drawings shall fully illustrate all requirements in the contract documents. Include the following information, as applicable:
    a. General arrangement of each product or assembly by necessary plans, elevations and sections.
    b. Dimensions, finishes, part numbers, location in the building and details of fabrication and installation.
    c. Any equipment with electric motors or wiring must show wiring diagram and schematics. Lack of either will be cause for automatic rejection of the submittal.
    d. Identification of products.
    e. Schedules.
    f. Compliance with specified standards.
    g. Notation of coordination requirements.
    h. Notation of dimensions established by field measurement.
    i. Relationship and attachment to adjoining construction clearly indicated.
    j. Seal and signature of professional engineer, if specified.
5. Sheet Size: Except for templates, patters, and similar full-size drawings, submit shop drawings on electronic sheets at least 8-1/2 by 11 inches, but no larger than 22 by 34 inches.
6. Format: Submit shop drawings in PDF electronic format. At the Engineer's request, submit up to 3 hard copies.

D. Product Data
1. Product Data shall include the following information, as applicable:
    a. Manufacturer's catalog cut sheets
    b. Manufactuerer's product specifications and details
    c. Performance characteristics
    d. Wiring diagrams
    e. Test data
    f. Installation instructions
    g. Standard color charts
    h. Statement of compliance with specified reference standards
    i. Testing by recognized testing agency
    j. Application of testing agency labels and seals
    k. Notation of coordination requirements
    l. Availablilty and delivery time information
2. Product Data shall be submitted with a cover letter stating exact product by name and number and how it complies with the Contract Documents.
3. Format: Submit product data in PDF electronic format. At the Engineer's request, submit up to 3 hard copies.

E. Samples
1. Submit 3 identical sets for each material, finish and color required.
    a. For unit materials (such as brick, floor or ceiling tile), provide standard size units in sufficient quantity to show the full range.
    b. For finishes applied over large areas (such as wall covering, carpet, ceramic tile, plywood), provide 12-inch x 12-inch minimum size samples or larger, as required, to show full range or repeat pattern.
    c. For linear products, such as door and window frames or trim pieces, submit 12-inch minimum lengths of the actual product.
2. Full-Size Samples: Where required, submit a full-size unit of a specified product as a sample. Such sample may be used in the finished work if:

a. It is approved for such use by Engineer.
b. It is protected and in first-class condition.
c. It matches the balance of the product used on the Project.

F. Reference Submittals
1. All calculations shall have the Professional Engineer's seal affixed, and shall be submitted prior to starting fabrication or installation. Engineer shall not be responsible for calculations of such other Professional Engineers. The Professional Engineer shall be registered in the State of Ohio.
2. Calculations, where required for the preparation of Shop Drawings, shall be submitted with those Shop Drawings and not as a separate submittal. Shop Drawings submitted without calculation backup sheets will be returned unreviewed.

G. Submittal Process
1. As soon as practical after executing the Contract, or as required by other Contract Documents, request from each Subcontractor and submit properly processed and identified items as required in the Specifications.
a. Late or untimely submittal of information shall not be cause to reduce Engineer's review time, to accept lower quality, or to delay the project completion.
2. Contractor shall be solely responsible for scheduling and coordinating of submittals among Subcontractors.
3. Allow a minimum of 14 working days for processing (from the date the Reviewer receives submittal until the date he sends it back) and sufficient time for proper handling, review, fabrication and delivery. If many items are submitted simultaneously, substantially more time for processing shall be required if Engineer so determines.
4. Send a separate Transmittal Letter with each submittal by specification number, using the form provided by the Engineer. List and identify each item on the Transmittal Letter. Include Engineer's project identification number and other requested information on the transmittal letter or on the submittal being sent.
5. When Shop Drawings are revised and resubmitted, all the revised, added and/or deleted items since the previous submittal must be circled by the submitter.
6. The entire submittal of Shop Drawings will be returned unreviewed when revised, added and/or deleted items have not been circled.
7. Shop Drawings that are submitted for reference as an aid to review another portion of the work will not be reviewed.

H. Form of Submittal
1. Shop Drawings shall be submitted in PDF electronic format. The sheet size of the electronic PDF shall generally be 22-inch x 34-inch or 11-inch x 17-inch and shall be filled completely to minimize the number of sheets.
2. Submittals for Product Data shall be submitted in PDF electronic format. The sheet size of the electronic PDF shall generally be 8-1/2-inch x 11-inch.
a. Provide minimum blank space of 3-inch x 8-1/2-inch on each submittal for review stamps of Contractor and Engineer.
b. When submitting product data, submit only catalog pages showing the item to be furnished and identify the item on the page and on a separate cover letter stating how it complies with the Contract Documents.
3. Where Samples are requested, submit three complete sets of the sizes indicated.
4. Mark each item with the same identifying number used on the Transmittal Letter and include the following information:
a. Project name and number

b. Contractor's name, address and telephone number
c. Subcontractor's name, address and telephone number
d. Supplier's name, address and telephone number
e. Date of submittal
f. Specification section number or Drawing number
g. Status (new or prior submittal date and number)

I. Contractor's Check
1. Upon receipt of submittals, check each item for:
a. Conformance to submittal requirements
b. Conformance of materials and details to the Contract Documents
c. Accuracy of all measurements
d. Field construction criteria related thereto
2. Reject items which do not conform to these requirements and return them to the originator with an explanation for the rejection. Do not submit rejected items to Engineer.
a. Do not submit Shop Drawings, Product Data, or Samples that are not requested in the Technical Sections.
3. For items approved by the Contractor, stamp each item "APPROVED" to warrant and represent approval.
4. Contractor is totally responsible for the following items which will not be reviewed by the Engineer or by Owner:
a. Deviations from Contract Documents.
b. Dimensions to be confirmed and correlated at the Site.
c. Fabrication process information
d. Means, methods, techniques, sequences, procedures of construction and construction safety.
e. Coordination of the work of all trades.
f. Reference Submittals

J. Engineer's Review
1. Deliver or send each item, shipping charges prepaid, to Engineer.
2. Engineer immediately will reject any item without further review if it is not:
a. Accompanied by a Transmittal Letter containing the required information
b. Submitted as a reproducible
c. Stamped "APPROVED" by the Contractor
3. If the submittal has been previously submitted and was marked "CONFORMS" or "CONFORMS AS NOTED" and the transmittal letter does not state that additional corrections or additions to the submittal have been made, then such submittal shall not be reviewed again.
4. Review will be for conformance to the design concept and compliance with information given in the Contract Documents. Engineer will make notations directly on the electronic PDF copy.
5. Review is intended to foresee unacceptable products and to minimize the possibility of their rejection at the Site. The review shall not be construed as:
a. Permitting a departure from the Contract Documents, unless specifically so noted.
b. Relieving the Contractor of responsibility for errors or omissions.
c. Acceptance of an assembly of which an approved item is a part.
d. Approval of variations from previously approved items.
e. Approval of dimensions.

6. Engineer will review all Samples. Such review will be for appearance only. Compliance with all other requirements of the Contract Documents is the responsibility of the Contractor.
7. Product Data: Only the cover letter will be stamped with the Shop Drawing stamp, and not the product data sheets.
8. Reference Submittals shall be sent to Engineer for informational purposes only.
    a. Refer to Technical Sections under Reference Submittals for required information to be submitted.
    b. The contents of such submittals and compliance with all other requirements of the Contract Documents shall be the responsibility of the Contractor.

K. Variations from Contract Documents
1. If Engineer determines a variation from the Contract Documents is in the best interest of the Owner, and it does not involve a change in the Contract price or time, he may permit such variation and stamp the item "CONFORMS".
2. Unless Engineer receives immediate written notification, he will assume the Contractor approves any variation shown.
3. If Contractor fails to mention variations from the Contract Documents, he will not be relieved of responsibility for executing the work in accordance with the Contract Documents.
4. When a variation from the Contract Documents is permitted and such variation involves corresponding adjustment in an adjacent or related item, responsibility for making and paying all costs for such adjustment rests with the Contractor requesting the original variation. Additional services required of Engineer, shall be paid for by Contractor. Payment for such additional services shall be made as follows:
    a. Owner shall compensate Engineer for such additional services and Owner shall deduct amount of such compensation from payments due to the Contractor.

L. Reviewer's Stamp and Letter of Acknowledgement
1. Each Shop Drawing, Product Data cover letter or Sample processed by Engineer (except reference submittals).
2. If the item conforms to all requirements of the Contract Documents or if the item contains permitted variations, it will be stamped "CONFORMS".
3. If the item is marked-up by the Contractor or Engineer to make it conform and such mark-ups are not extensive, it will be stamped "CONFORMS AS NOTED".
4. If the item does not conform to the Contract Documents and the variation is not permitted, or if the item is extensively marked-up, it will be stamped "DOES NOT CONFORM".
5. Except for field test reports, receipt of Reference Submittals will be acknowledged by Letter of Acknowledgement and no stamp will be placed on such submittals. Sample attached at the end of this Section.

M. Rejection and Resubmittal
1. Items which do not meet the requirements of this Section, or are stamped "DOES NOT CONFORM", will be returned for correction and resubmittal by the same process. Engineer will indicate reasons for the rejection and will retain one print or sample to check against resubmittal.
2. Any item not prepared as required by the Contract Documents or not prepared in a professional or workmanlike manner requiring excessive review time, including items that require more than 2 submittals, shall be assessed a back charge by Owner for such extra time. Payments for such additional services shall be made as follows:

a. Owner shall compensate Engineer for such additional services and Owner shall deduct amount of such compensation from payments due to the Contractor.

3. Make the indicated changes only, unless further change is required for conformance to the Contract Documents.
4. Direct attention on the item to all revisions. Explain all revisions, other than those requested, in detail on the transmittal form.
   a. All revised and/or added items since the previous submittal must be circled.
   b. The entire submittal will be returned unreviewed when revised or added items have not been circled.
5. Contractor shall be completely responsible for changes not indicated or specifically noted as revised.

N. Acceptance and Use
1. Items stamped "CONFORMS AS IS" or "CONFORMS AS NOTED" will be returned to Contractor.
2. Distribute electronic copies as required to transmit the information to all parties involved.
3. Engineer will retain conforming Shop Drawings and Product Data as well as one sample, for comparison with work installed.
4. Keep copies of each approved item on the job Site at all times for reference.
5. Retain the original electronic submittal until Final Completion of the work and turn them over to Engineer for the Owner's file.
6. Do not commence work requiring Shop Drawings, Product Data, Samples, and Reference Submittals until submittal has been processed by Engineer. Perform all work in accordance with such submittal.
7. No work shall be performed without a required submittal having the proper Engineer stamp stating "CONFORMS" or "CONFORMS AS NOTED".

1.5 QUALITY CONTROL SUBMITTALS

A. Certificates
1. Installer Qualification is required for all installers of product systems listed as requiring such in the "Submittals" paragraphs of the technical specifications. Installer Certification shall consist of written certification from the manufacturer of the product system listed certifying that the Installer is approved by the manufacturer for installing the specified product system. Submit an electronic PDF copy of certification with the Subcontractor and Material List prior to Contract signing.
2. Material Certification is required for all materials listed as requiring such in the "Submittals" paragraphs of the technical specifications. Material Certification shall consist of written certification from the manufacturer of the material listed certifying that all such material used in the work meets the requirements specified in the Contract Documents and is being utilized in conformance with the manufacturer's recommendations. Submit electronic PDF copy of certification as work progresses.
3. Surveyor's Certification
   a. A certification shall be a written statement certifying the correctness of the data reported and sealed by a surveyor registered in the state where the project is located. A report shall consist of reduced field notes, sketches, or dimensions marked on copies of the Construction Drawings.
   b. Contractor shall submit certifications during the construction of the Project from a registered surveyor that the critical locations and elevations of the construction are in accordance with the Contract Documents.

1) Items for certification shall include, but not be limited to, all structures, pipes, utilities, and other underground and aboveground construction, such as bottom of footings, top of footings, floor elevations, elevations of pipe centerline.
2) Report all deviations from the Contract Documents both critical and those that are not critical.

c. Report horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

d. Report location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.

e. Reports shall be submitted timely before and after construction. For example report and certify footing locations before and immediately after construction of the footings.

B. Manufacturer's Instructions

1. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including a PDF electronic copy to the Engineer.
   a. Maintain 1 set of complete instructions at the jobsite during installation and until completion.
2. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements.
   a. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with the Engineer for further instructions.
   b. Do not proceed with work without clear instructions.
3. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

1.6 INFORMATION REQUESTS, AND PROPOSED DEVIATIONS

A. General: Questions which arise during construction concerning the Contract Documents and the interpretation thereof, shall be submitted in writing to Engineer for his comments. Questions that can be answered by review of the Contract Documents shall not be submitted to Engineer.

B. Proposed Deviation

1. Questions concerning proposed deviations from the Contract Documents to accommodate construction shall be documented and submitted to the Engineer for his review.
   a. Such documentation shall include a proposed solution with detailed drawings and written substantiation for the proposed deviation.
   b. This shall not be construed as a means of submitting substitutions of manufacturers, products, materials, equipment, or systems. Substitutions shall not be submitted except as permitted in Division 1 Section “Material and Equipment”.
2. Do not proceed with such deviations until written notice to proceed has been received from Engineer.
   a. Such written notice shall not relieve Contractor from conformance to the Contract Documents.
3. All reviews by Engineer of proposed deviations submitted by Contractor which would provide any benefit to Contractor and all reviews by Engineer of requests for deviations which are, in fact, requests for substitutions shall be paid by Contractor, even though the request may be denied, as follows:

a. Owner will compensate Engineer.
b. Owner will deduct the amount of such compensation from payments to Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 3300

SECTION 01 3543.13

ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Contractor shall develop, implement, and maintain a Hazardous Materials management program (HMMP) throughout the Project, in accordance with Laws and Regulations.
   1. Hazardous Materials Brought to Site by Contractor: Transport, handle, store, label, use, and dispose of in accordance with this Section, and Laws and Regulations.
   2. Hazardous Material Generated by Contractor:
      a. Hazardous Material shall be properly handled, stored, labeled, transported and disposed of by Contractor in accordance with Laws and Regulations, and this Section.
      b. If Contractor will generate or has generated Hazardous Material at the Site, obtain a United States Environmental Protection Agency (EPA) identification number listing Contractor's name and address of the Site as generator of the Hazardous Material. Obtain identification number from state environmental agency or similar authority having jurisdiction at the Site. Submit identification number within time frame specified in Article 1.3 of this Section.
      c. Contractor shall be responsible for identifying, analysis of, profiling, transporting, and disposing of Hazardous Material generated by Contractor.
   3. Fines or civil penalties levied against OWNER for violations committed at the Site by Contractor, and costs to Owner (if any) associated with cleanup of Hazardous Materials shall be paid by Contractor.

B. Enforcement of Laws and Regulations:
   1. Interests of Owner are that accidental spills and emissions, Site contamination, and injury of personnel at the Site are avoided.
   2. When Owner is aware of suspected violations, Owner will notify Contractor, and authorities having jurisdiction if Owner reasonably concludes that doing so is required by Laws or Regulations.

C. Related Sections:
   1. Section 01 3544, Spill Prevention Control and Countermeasures Plan.

1.2 DEFINITIONS:

A. The following terms are defined for this Section and supplement the terms defined in the General Conditions:
   1. Hazardous Material: Material, whether solid, semi-solid, liquid, or gas, that, if not stored or used properly, may cause harm or injury to persons through inhalation, ingestion, absorption or injection, or that may negatively impact the environment through use or discharge of the material on the ground, in water (including groundwater), or to the air. Hazardous Material includes, but is not limited to, chemicals, Asbestos, Hazardous Waste, PCBs, Petroleum, Radioactive Material, and which is or becomes listed, regulated, or addressed pursuant to [a] the Comprehensive Environmental Response, Compensation and Liability Act, 42 United States Code (USC) §§9601 et seq. ("CERCLA"); [b] the

Hazardous Materials Transportation Act, 49 USC §§1801 et seq.; [c] the Resource Conservation and Recovery Act, 42 USC §§6901 et seq. ("RCRA"); [d] the Toxic Substances Control Act, 15 USC §§2601 et seq.; [e] the Clean Water Act, 33 USC §§1251 et seq.; [f] the Clean Air Act, 42 USC §§7401 et seq.; and [g] any other Law or Regulation regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.

1.3 QUALITY ASSURANCE:

A. Regulatory Requirements: Laws and Regulations applying to the Work under this Section include:
   1. Code of Federal Regulations (CFR), Title 29, Part 1910, Occupational Safety and Health Standards.
   2. CFR, Title 29, Part 1926, Safety and Health Regulations for Construction.
   3. CFR Title 40, Protection of Environment.
   4. CFR, Title 49, Transportation.
   5. Occupational health and safety requirements of state labor department or similar entity; environmental Laws and Regulations of state environmental agency, Laws and Regulations of state department of transportation.

1.4 SUBMITTALS:

A. Informational Submittals: Submit the following to the entity(ies) specified for each:
   1. Hazardous Materials (including Chemicals) Proposed for Use at the Site: Submit current (dated within the past two years) material safety data sheets (MSDS) in accordance with 29 CFR 1910.1200 (OSHA Hazard Communication Standard), manufacturer, Supplier (if different than manufacturer), container size(s) and number of containers proposed to be at the Site, minimum and maximum volume of material intended to be stored at the Site, and description of process or procedures in which Hazardous Material will be used. Furnish information in sufficient time to obtain Owner's acceptance no later than least three days before bringing Hazardous Material to the Site. Submit to Engineer and Owner's environmental representative.
   2. Hazardous Material Generated at the Site: Submit for each Hazardous Material generated at the Site identification number, analysis results, and number and size of storage containers at the Site. Furnish information not less three days of Contractor's receipt of analytical results. Submit to Engineer and Owner's environmental representative.
   3. Permits: Copies of permits for storing, handling, using, transporting, and disposing of Hazardous Materials, obtained from authorities having jurisdiction. Submit to Owner's environmental representative and Engineer.
   4. Other Documents required for the HMMP: Submit to Owner's environmental representative requested documents within three days of Contractor's receipt of request. HMMP documents may include emergency/spill response plan, communication plan, and other documents.
   5. Qualifications Statements:
      a. Contractor's Safety Representative: Submit qualifications of proposed safety representative, including summary of experience, training received, and valid certifications applicable to the Project.

1.5 HAZARDOUS MATERIALS MANAGEMENT:

A. Obtain Owner's environmental representative's acceptance before bringing each Hazardous Material to the Site.

B. Communication Plan: Contractor shall develop a Hazardous Materials communication plan. At minimum, maintain at the Site two notebooks containing: 1) Inventory of Hazardous Materials (including all chemicals); and, 2) Current (dated within the past two years) material safety data sheets (MSDS) for all materials being used to accomplish the Work, whether or not defined as Hazardous Material in this Section. Keep one notebook in Contractor's field office at the Site; keep second notebook at location acceptable by Owner's environmental representative. Keep notebooks up-to-date as materials are brought to and removed from the Site.

C. Emergency/Spill Response Plan: Develop, implement, and maintain an emergency/spill response plan, for each Hazardous Material or each class/group of Hazardous Materials as applicable. At minimum, response plan shall include the following:
   1. Description of equipment available at the Site to contain or respond to emergency related to or spill of the material.
   2. Procedures for notifying, and contact information for: authorities having jurisdiction, emergency responders, Owner, Engineer, the public as applicable, and other entities as required.
   3. Response coordination procedures between Contractor, Owner, and others as appropriate.
   4. Site plan showing proposed location of Hazardous Materials storage area and location of spill containment/response equipment, and location of storm water drainage inlets and drainage routes.
   5. Description of Hazardous Material handling and spill response training provided to Contractor's and Subcontractors' employees, in accordance with 29 CFR 1926.21(b) and other Laws and Regulations..
   6. Comply with Section 01 3544, Spill Prevention Control and Countermeasures Plan.

D. Storage of Hazardous Materials and Non-Hazardous Materials:
   1. Hazardous Materials containers shall bear applicable hazard diamond(s).
   2. Container Labeling:
      a. Properly label each container of consumable materials, whether or not classified as Hazardous Materials under this Section.
      b. Stencil Contractor's name and, as applicable, Subcontractor's name, on each vessel containing Hazardous Material and, for non-Hazardous Materials, on each container over five-gallon capacity. Containers shall bear securely-attached label clearly identifying contents. Label containers that are filled from larger containers.
      c. If Owner becomes aware of unlabeled containers at the Site, Owner's environmental representative will notify Contractor. Properly label container(s) within one hour of receipt of notification or remove container from the Site.
   3. To greatest extent possible, store Hazardous Materials off-Site until required for use in the Work.

E. Hazardous Materials Storage Area:
   1. Maintain designated storage area for Hazardous Materials that includes secondary containment. Storage area shall include barriers to prevent vehicles from colliding with storage containers and shall include protection from environmental factors such as weather.
   2. Provide signage in accordance with Laws and Regulations, clearly identifying the Hazardous Materials storage area.

F. Contractor's safety representative shall meet at least monthly with Owner's environmental representative to review Contractor's HMMP documents, procedures, and inspect storage areas and the Site in general, to verify compliance with this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01 3543.13

SECTION 01 3544

SPILL PREVENTION CONTROL AND COUNTERMEASURES PLAN

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Contractor shall provide all labor, materials, equipment, tools, professional engineering (when required), and incidentals as shown, specified, and required to comply with Laws and Regulations regarding spill prevention control and countermeasures (SPCC) planning and compliance, including 40 CFR Part 112.

B. Contractor shall determine whether a SPCC Plan is required. If SPCC Plan is required, Contractor shall prepare, implement and maintain SPCC Plan as required by Laws and Regulations.

C. Determination of Need for SPCC Plan:
   1. Contractor shall determine need for SPCC Plan.
   2. Professional Engineer:
      a. If the Site will include storage of more than 10,000 gallons of oil in above-ground storage, or if the Site does not comply with oil discharge history criteria specified in 40 CFR 112, Contractor shall retain a qualified professional engineer to determine need for SPCC Plan and, if SPCC Plan is required, professional engineer shall prepare or supervise preparation of SPCC Plan.
      b. If a professional engineer is not required to prepare the full SPCC Plan, but the SPCC Plan includes environmentally-equivalent SPCC measures, or impracticality determinations, Contractor shall retain a qualified professional engineer to prepare and certify those portions of the SPCC Plan dealing with environmentally equivalent measures and impracticality determinations; the balance of the SPCC Plan may be prepared by and self-certified by Contractor.
   3. Submit to Engineer letter presenting results of evaluation of whether a SPCC Plan is required for the Project in accordance with Laws and Regulations.

D. SPCC Plan is required if the Project activities at the Site meet the following criteria:
   1. The Site and activities thereon are not exempt from Laws and Regulations.
   2. Oil is stored, used, transferred, or otherwise handled at the Site.
   3. Maximum oil storage capacity at the Site equals or exceeds either of the following thresholds: 42,000 gallons of completely buried capacity, or 1,320 of above-ground capacity. Capacity includes total storage tank volume and operational storage volume at the Site for contractors and Subcontractors, including bulk storage tanks, containers with 55-gallon storage capacity and larger, mobile tanks located at the Site, and other containers covered by Laws and Regulations. Motive storage containers, such as those on construction equipment and vehicles, is not included. Oil includes petroleum products, fuel oil, hydraulic fluid, oil sludge, oil refuse, oil mixed with wastes other than dredged material, synthetic oil, vegetable oil, animal fats and oils, and other oils defined in Laws and Regulations.
   4. There is reasonable expectation, based on location of the Site, that oil spill would reach navigable waters of the United States or adjoining shorelines.

E. If SPCC Plan is not required, Contractor shall ensure that conditions that preclude the need for SPCC Plan, including the activities of all contractors and Subcontractors at the Site, are maintained throughout duration of the Project. Should changes that affect the storage, use, or handling of oil at the Site occur, reassess the need for SPCC Plan at no additional cost to Owner and provide to Engineer evaluation letter regarding need for SPCC Plan.

F. If SPCC Plan is required, develop SPCC Plan and submit for acceptance by Owner, with copy to Engineer. SPCC Plan shall be specific to the Site and shall include the following:

1. Stamp, original signature, and license number of Contractor'S professional engineer, when self-certification by Contractor is not allowed by Laws and Regulations.
2. Site plan identifying the name (or tag number) and location of each tank and container that will contain a substance regulated in 40 CFR 112 and other Laws and Regulations, including above-ground and buried tanks. Site plan shall indicate general directions of storm water runoff, including storm sewers and drainage inlets, and storm sewer outfall locations.
3. For each tank and container on the Site plan, provide a table that lists the tank or container's name and tag number, type of oil stored, and maximum storage capacity. List total storage capacity of all tanks and containers at the Site covered by SPCC Laws and Regulations.
4. Predictions of direction, rate of flow, and total quantity of oil that could be discharged from the Site as result of storage tank or container failure.
5. Operating procedures that prevent oil spills, including procedures for oil handling, details of secondary containment structures at fuel and oil transfer areas, and details and descriptions of equipment to be used for oil handling, including piping.
6. Details of and descriptions of control measures installed at the Site by Contractor to prevent spill from reaching navigable waters, including secondary containment and diversionary structures. For on-shore Sites, one of the following must be used, at minimum: dikes, berms, or retaining walls; curbing; culverts, gutters, or other drainage systems; weirs, booms, or other barriers; spill diversion ponds; retention ponds; sorbent materials. Where appropriate, the SPCC Plan shall clearly demonstrate that containment or diversionary structures or equipment are not practical. Include brittle fracture evaluation, where required, for field-constructed above-ground storage containers undergoing repair, alteration, construction, or change in service.
7. Plans for countermeasures to contain, clean up, and mitigate effects of oil spill that reaches navigable waters, including written commitment of manpower, equipment, and materials to quickly control and remove spilled oil. Include estimation of time required to contain spill after spill occurs.
8. Contact list and telephone numbers for facility response coordinator, National Response Center, cleanup contractors, and all appropriate federal, state, and local authorities having jurisdiction to be contacted in event of spill or discharge.
9. Program for monthly inspections of the Site by Contractor for SPCC Plan compliance. Notify Owner of each inspection at least 72 hours in advance.
10. Measures for Site security relative to oil storage.
11. Procedures for safely handling mobile containers such as totes, drums, and fueling vehicles and construction equipment that remain at the Site.
12 Procedures and schedules for periodic testing of integrity of tanks and containers, and associated piping and valves.
13. Plans for bulk storage container compliance.
14. Plans for personnel training and oil spill prevention briefings.
15. For SPCC Plans that do not follow the format listed in Laws and Regulations, provide cross-reference to requirements of Laws and Regulations, including 40 CFR 112.7.

G. Obtain acceptance of SPCC Plan by Owner, for coordination with Owner's Site-specific SPCC Plan, if any.

H. SPCC Plan shall be reviewed by Contractor's professional engineer (when professional engineer is required) and Owner every five years, as applicable.

I. Post a copy of accepted, certified SPCC Plan in conspicuous location at the Site and provide copies to Owner, Engineer, other contractors, and Subcontractors as appropriate. All contractors shall comply with SPCC Plan.

J. In event of violation of SPCC Plan or release of oils attributable to construction operations, Contractor shall:
   1. Immediately issue notifications in accordance with Laws and Regulations, including 40 CFR 110 and 40 CFR 112. When required by Laws and Regulations, report to National Response Center, US Environmental Protection Agency, and other authorities having jurisdiction, if any.
   2. Have spill clean-up performed in conformance with Laws and Regulations and the SPCC Plan.
   3. Pay fines or civil penalties (or responsible portion thereof) imposed on Owner by authorities having jurisdiction, and pay costs associated with clean-up of pills.

1.2 QUALITY ASSURANCE:

A. Qualifications:
   1. Professional Engineer:
      a. When required by Laws and Regulations, engage a registered professional engineer legally qualified to practice in the jurisdiction where the Site is located and experienced in providing engineering services of the kind indicated.
      b. Submit qualifications data.
      c. Responsibilities include but are not necessarily limited to:
         1) Carefully reviewing Laws and Regulations relative to SPCC.
         2) Preparing written requests for clarifications or interpretations of criteria specified in the Contract Documents for submittal to Engineer by Contractor, and obtaining from authorities having jurisdiction clarifications regarding Laws and Regulations as required.
         3) Preparing or supervising the preparation of letter-report evaluation of need for SPCC Plan in accordance with the Contract Documents. Evaluation shall include professional engineer's seal, registration number, and original signature.
         4) When SPCC Plan is required, preparing, supervising the preparation of, or reviewing the SPCC Plan (or designated portions thereof when oil storage at the Site will be 10,000 gallons or less) in accordance with the Contract Documents. SPCC Plan (or designated portions thereof) shall include professional engineer's seal, registration number, and original signature.
         5) Periodically re-evaluating the need for SPCC Plan and issuing findings as letter-reports with seal, license number, and signature. When SPCC Plan is required, periodically evaluating the SPCC Plan and providing recommendations for compliance with Laws and Regulations, in accordance with the Contract Documents.
         6) Certifying that:
            a) it is familiar with the Laws and Regulations, including 40 CFR 112, and

b) it has visited, examined, and is familiar with the Site, planned modifications to the Site under the Project as such modifications pertain to SPCC Laws and Regulations, and
c) it has performed the evaluations and prepared SPCC Plan in accordance with the Contract Documents, and
d) procedures for required testing and inspections have been established, and
e) the said evaluations and SPCC Plan are adequate for the Project, and
f) the said evaluations and SPECC Plan conform to all Laws and Regulations, applicable industry standards, and to prevailing standards of practice.

1.3 SUBMITTALS:

A. Informational Submittals: Submit the following:
1. Certifications: With each evaluation letter and SPCC Plan submittal, include certification signed by preparer of submittal that the submittal conforms to the Contract Documents and Laws and Regulations. Signature on all certifications shall be original.
2. Evaluations:
a. Submit letter presenting results of evaluation of whether a SPCC Plan is required for the Project. Submit evaluation no later than fourteen days after the Contract Times commence running, unless longer time is allowed by Engineer.
b. Submit updated evaluations as required when conditions at the Site change. Submit updated evaluation no later than seven days after the conditions at the Site change, or within seven days of Engineer's request, unless longer time is allowed by Engineer.
3. SPCC Plan: When SPCC Plan is required:
a. Submit jointly to Owner and Engineer. Submit within fourteen days of receipt of Engineer's acceptance of evaluation submittal.
b. Update and resubmit the SPCC Plan, or acceptable SPCC Plan amendments, as required when conditions at the Site change. Submit updated SPCC Plan or amendments no later than seven days after the change in conditions at the Site change giving rise to the SPCC Plan change or amendment, or within seven days of Engineer's request, unless longer time is allowed by Engineer.
4. SPPC Plan Distribution: When SPCC Plan is required, submit copies of letters transmitting SPCC Plan and amendments (if any) to contractors and Subcontractors working at the Site.
5. Qualifications Statements: Contractor's professional engineer, when requested by Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 01 35 44

SECTION 01 4100

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 STANDARDS, CODES AND REGULATIONS

A. Standards, codes, and regulations published by manufacturers' associations, governmental agencies and other regulatory authorities form a part of these Specifications as minimum requirements. Such references include the latest issue and all amendments up to 60 days prior to the date of the Contract Documents.

B. Where differences occur between the Contract Documents and such standards, the most strict requirements shall take precedence.

C. Supply all materials and perform all work in accordance with the manufacturer's Specifications and installation procedures, and in conformance with published trade and manufacturers' association standards, unless specifically noted otherwise herein.

1.3 PERMITS

A. Owner will or has secured and paid for all permits listed in Division 00, Section “Supplementary Conditions”.

B. Contractor shall secure and pay for all other permits and governmental fees, licenses and inspections necessary for the proper execution and completion of the work which are customarily secured after execution of the Contract and which are legally required at the time the Bids are received.

C. If required by governmental authority, Owner will make application for permits and licenses using forms obtained and prepared by the Contractor and with all costs paid by the Contractor.

1.4 TAXES

A. Materials and labor to be incorporated into permanent construction are exempt from Ohio state sales tax. Sales exemption certificate will be issued by the Owner to the Contractor. Contractor shall pay all other taxes required by law. The Bid Price, whether a unit price, lump-sum price, lot price, or a trade discount price, shall be exclusive of all exempt taxes and shall be so construed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 4100

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SECTION 01 4126

STORMWATER POLLUTION PREVENTION PLAN AND PERMIT

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Contractor shall comply with the Project's National Pollutant Discharge Elimination System (NPDES) Permit for The State of Ohio. Contractor shall be a co-permittee with Owner and is responsible for providing necessary materials and taking appropriate measures to comply with requirements of the permit and minimize pollutants in storm water runoff from the Site.

B. Documents: The following are part of the Work included under this Section:
   1. Storm Water Pollution Prevention Plan (SWPPP): Prepared by Owner and filed with authority having jurisdiction over storm water discharges during construction. The SWPPP is part of the Contract Documents.
   2. Sediment and Erosion Control Permit: Prepared by Owner and filed with the authority having jurisdiction over sediment and erosion control during construction. Sediment and erosion control permit is part of the Contract Documents.
   3. SWPPP Revisions: Prepared by Contractor and submitted to Engineer. At minimum, Contractor shall file a SWPPP Revision prior to starting Work at the Site, and as required by authorities having jurisdiction. SWPPP Revision shall include Contractor's proposed temporary means for storm water control during all phases of the Work and include plans for storm water conveyance and retention, as applicable. Coordinate with excavation plan submittals required in Division 31 of the Specifications. Should Contractor propose deviations to the SWPPP included in the Contract Documents, or if Project-specific modifications of the SWPPP are required to conform to field conditions, Contractor shall provide additional SWPPP Revisions as necessary, in accordance with requirements of authorities having jurisdiction and applicable permits. SWPPP Revisions shall use the SWPPP Revision form included in this Section, with supporting documents attached as required, or forms provided by authorities having jurisdiction. SWPPP Revisions that do not comply with the Contract Documents and are not required by authorities having jurisdiction will be regarded as substitutions, in accordance with the General Conditions and substitution procedures in the Specifications.
   4. Storm Water Certification Statement: To be provided by Contractor to Engineer on the form included with this Section, or on a form provided by authority having jurisdiction. Do not perform Work at the Site until the Storm Water Certification has been submitted to Engineer.
   5. Notice of Intent (NOI): Prepared by Owner or Engineer and submitted to authorities having jurisdiction following Engineer's receipt and acceptance of Contractor's SWPPP Revision and preliminary Progress Schedule. NOI will be filed with authorities having jurisdiction by Engineer within ten days of Engineer's acceptance of Contractor's SWPPP Revision and preliminary Progress Schedule. Do not perform Work at Site until NOI is submitted to authorities having jurisdiction.
   6. Co-permittee Agreement: Prepared by Contractor using forms included with the SWPPP, and submitted to Engineer within five days of the date the Contract Times commence running, for signature by Owner. Engineer will file co-permittee agreement with authorities having jurisdiction. Do not perform Work at the Site until co-permittee agreement is submitted to authorities having jurisdiction.

7. Storm Water Inspection Report: Prepared by Engineer's Resident Project Representative (RPR) using the form included with this Section, or a form provided by authority having jurisdiction. Storm water inspection reports will be filed in a log book kept at the Site by Engineer. Copy of each report will be furnished to Contractor upon request. Storm water inspection report will be completed for each of the following:
    a. Pre-construction: After placement of storm water management measures, including sediment and erosion controls, and temporary field offices and other temporary facilities, prior to starting other Work at the Site.
    b. During the Work: Every seven days until Notice of Termination is completed. When the Site is stabilized relative to storm water, erosion, and discharge of sediment, inspection frequency during temporary shutdowns and seasonal shutdowns is once per month until Notice of Termination is completed.
    c. Final: Final inspection report will be prepared prior to completion of Notice of Termination.
8. Notice of Termination (NOT): Prepared by Contractor on the form included with storm water permit and provided to Engineer for review and signature by Owner. Engineer will submit the NOT to authority having jurisdiction. Submit the NOT following completion of all Work that may result in pollution in storm water discharges, including landscaping Work. Final Payment will not be made until the NOT is filed with authority having jurisdiction.

C. Prevent discharge of sediment to and erosion from the Site to surface waters, drainage routes, public streets and rights-of-way, and private property, including dewatering operations. Prevent trash and demolition and construction debris from leaving the Site via storm water runoff. Provide berms, dikes, and other acceptable methods of directing storm water around work areas to drainage routes. Prior to starting the Work associated with such discharge, construction-related discharges to publicly owned conveyance or treatment systems shall be approved by owner of system to which the discharge will be directed.

D. Do not cause or contribute to a violation of water quality standards, Laws, or Regulations. Notify Engineer of revisions to the SWPPP necessary to protect receiving water quality and comply with applicable permits. Provide and implement measures to control pollutants in storm water runoff from the Site to prevent:
1. Turbidity increases that will cause a substantial visible contrast to natural conditions.
2. Increase in suspended, colloidal, and settleable solids that would cause sediment deposition or impair receiving water quality and use.
3. Presence of residue from oil and floating substances, visible oil, and globules of grease.

E. Contractor shall pay civil penalties and other costs incurred by Owner, including additional engineering, RPR, and inspection services, associated with non-complying with applicable permits related to storm water discharges associated with construction activity and sediment and erosion controls associated with the Work.

F. Contract Price includes all material, labor, and other permits and incidental costs related to:
1. Preparing SWPPP Revisions and other documents that are Contractor's responsibility, in accordance with this Section.
2. Installing and maintaining structural and non-structural items used in complying with the SWPPP and its revisions.
3. Clean-up, disposal, and repairs following wet weather events or spills caused by Contractor.

4. Implementing and maintaining “best management practices”, as defined in applicable permits and Laws or Regulations, to comply with requirements that govern storm water discharges at the Site.
5. Inspections of storm water, sediment, and erosion controls as specified.

G. Coordinate requirements of this Section with requirements for earthwork, erosion control, and landscaping in the Contract Documents, applicable permit requirements, and Laws and Regulations.

H. Implement SWPPP controls and practices prior to starting other Work at the Site. Each contractor and subcontractor identified in the SWPPP and SWPPP Revisions shall sign a copy of the storm water certification statement.

1.2 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with Laws and Regulations relative to environmental protection and restoration, including:
1. Storm water permit applicable to the Work and Site.
2. State and local erosion and sediment control guidelines and requirements,
3. State and local storm water regulations and guidance.

1.3 SUBMITTALS:

A. Informational Submittals: Submit the following:
1. Submit the following, in accordance with Article 1.1 and Article 1.4 of this Section; for Projects involving Work at multiple Sites, submit each of the following for each Site, as applicable:
a. SWPPP Revisions.
b. Co-permittee Agreement.
c. Storm Water Certification Statement.
d. Notice of Termination
2. Approval to Discharge to Publicly-owned Treatment Works: For storm water discharges associated with construction activity that are discharged to a publicly owned conveyance or treatment system, prior to commencing discharges, submit system owner’s written approval for such discharges.
3. Storm Water Site Plan Updates: Within three days after each storm water inspection, submit updated storm water site plan.

1.4 SWPPP REVISIONS:

A. Contractor shall prepare a SWPPP Revision in accordance with the Project’s storm water permit when:
1. There is a significant change in design, construction, operation, or maintenance of the Project that significantly affects the potential of discharging pollutants to Waters of the United States, and has not otherwise been addressed in the SWPPP.
2. SWPPP proves to be ineffective relative to:
a. eliminating or significantly minimizing pollutants from sources identified in the SWPPP required by this permit, or
b. achieving general objectives of controlling pollutants in storm water discharges from permitted construction activity.

3. Prepare and submit SWPPP Revision identifying contractors and subcontractor responsible for implementing part of the SWPPP.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSPECTIONS AND REPAIRS:

A. Perform Site inspections and assessments as required in applicable storm water permit and this Section. Inspections and assessments shall be done by Contractor's site superintendent or project manager, together with Engineer's RPR.

B. Inspections:
   1. During the Work, Site inspections shall be performed:
      a. After SWPPP controls are provided and prior to starting other Work at the Site.
      b. During the Work: Every seven days until Notice of Termination is completed. When the Site is stabilized relative to storm water, erosion, and discharge of sediment, inspection required frequency during temporary shutdowns and seasonal shutdowns is once per month until Notice of Termination is completed
      c. Prior to Contractor submitting the Notice of Termination.
   2. During each inspection, verify sediment control practices and record approximate degree of sediment accumulation as percentage of acceptable sediment storage volume; inspect erosion and sediment control practices and record maintenance performed; observe and record deficiencies relative to implementation of the SWPPP. RPR or Engineer will complete Storm Water Inspection Reports and Contractor shall record and submit the following.
      a. Storm Water Site Plan: On a copy of the Site plan included in the Contract Documents or other map of the Site acceptable to Engineer, indicate extent of all disturbed areas and drainage pathways. Indicate areas expected to undergo initial disturbance or significant site work within the next fourteen days.
      b. Indicate on storm water site plan areas of Site that have undergone temporary or permanent stabilization.
      c. Indicate on storm water site plan all disturbed areas that have not undergone active site Work during the previous fourteen days.

C. Maintain at the Site a copy of storm water site plans from storm water inspection submit each storm water map to Engineer and RPR. RPR will maintain at the Site a log book with a copy of each Storm Water Inspection Reports.

D. Cooperate with representatives of authorities having jurisdiction during periodic visits to Site, and promptly provide information requested by authorities having jurisdiction.

E. Complete repairs to SWPPP controls in accordance with applicable requirements and to satisfaction of Engineer within two calendar days of each inspection.

3.2 ATTACHMENTS:

A. The documents listed below, following the "End of Section" designation, are part of this Specification Section. Notice of Intent (NOI) form, Co-permittee Agreement form, and Notice of Termination (NOT) form are included with storm water permit.

1. Storm Water Inspection Report form.
2. Storm Water Permit Certification form.
3. SWPPP Revision Form.
4. Storm Water Pollution Prevention Plan and Sediment and Erosion Control Plan.
5. Approval for Coverage under Oho EPA General Permit: OHC000004.

END OF SECTION 01 4126

STORM WATER INSPECTION REPORT

Owner:
Site:
Project:
Contractor:

Date of Inspection:_____
Day of Week:

S	M	T	W	T	F	S

Sheet No. _____ of _____ Sheets

If pertinent to the Operation	
Weather	
Temperature	

This inspection and maintenance form is to be used when the Work is subject to a Storm Water General Permit for Construction Activity. Inspections must be performed at least once every seven calendar days; for sites that are stabilized and temporarily shut down inspections may be reduced to once per month. Each erosion and sediment control measure installed on the Site is to be inspected and the Contractor must complete all required maintenance within two calendar days from the date of inspection.

Reason for this inspection: ☐ Pre-construction Site assessment
☐ Seven calendar day inspection
☐ Monthly inspection (when Site is stabilized and shut down)
☐ Post-construction inspection prior to Notice of Termination

Key for erosion and sediment control measures to be inspected: [Use the following designations in the table below] (1) mulch, (2) seed and mulch, (3) check dams, (4) haybale/strawbales, (5) silt fence, (6) sediment trap, (7) turbidity curtains, (8) pipe slope drains, (9) drainage structure inlet protection, (10) rolled erosion control products, (11) soil stabilizers, (12) construction entrances, (13) pipe inlet/outlet protection, (14) water diversion structures, (15) sedimentation basins, (16) cofferdams, (17) Other _____.

ID	**Location**	**Disturbance**		**Measure**		**Remarks** (Evaluate integrity of measure, describe evidence of erosion)	**Approximate Sediment Accumulation** (% of Depth)	**Maintenance Required?** (Y or N) (If Yes, Describe Below)
		Existing ? (Y or N)	**Next 14 Days?** (Y or N)	**Code #**	**Temp or Perm?** (T, P or NA)			
1								
2								
3								
4								
5								
6								
7								
						Remarks		

ID	Location	Disturbance		Measure		(Evaluate integrity of measure, describe evidence of erosion	Approximate Sediment Accumulation (% of Depth)	Maintenance Required? (Y or N) (If Yes, Describe Below)
		Existing? (Y or N)	**Next 14 Days?** (Y or N)	**Code #**	**Temp/Perm or N/A?** (T, P or NA)			
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								

DESCRIPTION OF REQUIRED MAINTENANCE AND ANY EXISTING DEFICIENCIES IN THE SWPPP:
Specify for each location using row ID number.

I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system to ensure that qualified personnel property gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that false statements made herein may be punishable by Law.

Signature: _____ Prepared: _____ Copy to Contractor: _____

_____

Resident Project Representative (Date) (Date)

Qualified Professional Name Arcadis U.S., Inc.
(w/Firm Name, if Consultant)

STORM WATER PERMIT CERTIFICATION

Contract Number:_____ Project:_____

Owner:_____

Each Contractor and Subcontractor identified in the Storm Water Pollution Prevention Plan (SWPPP) must certify that they understand the permit conditions and their responsibilities. Every Contractor and Subcontractor performing an activity that involves soil disturbance shall sign this certification and submit it to the Engineer prior to performing the Work. This certification shall be signed by an owner, principal, president, secretary, or treasurer of the firm.

> I certify under penalty of law that I understand and agree to comply with the terms and conditions of the SWPPP for the construction Site identified in such SWPPP as a condition of authorization to discharge storm water. I also understand that my firm and its employees and Subcontractors shall comply with the terms and conditions of Owner's general permit for storm water discharges from construction activities and that it is unlawful for any person to cause or contribute to a violation of water quality standards, Laws, or Regulations.

Firm: _____

Address: _____

City:_____ State_____ Zip_____

_____ _____ _____

Name (Print) Signature Date

_____

Title

STORM WATER POLLUTION PREVENTION PLAN (SWPPP) REVISION

Owner:
Site:
Project:
Contractor:

Date of Inspection: _____

Sheet No. _____ of _____ Sheets

This form shall be used when revisions to the current Storm Water Pollution Prevention Plan (SWPPP) are required by the Storm Water General Permit for Construction Activity or the Contract Documents.

Reason for the Revision(s): Revisions were requested by State: ☐ Yes ☐ No

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Describe the Revision(s) to the SWPPP: _____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that false statements made herein may be punishable by Law.

Signature: _____ Prepared: _____ (Date) Submitted: _____ (Date)

Copy to: ☐ Engineer ☐ Contractor _____

SECTION 01 4500

QUALITY CONTROL

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 QUALITY ASSURANCE

A. General: The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work. The Contract Documents are complementary, and what is required by any one shall be as binding as if required by all. Work not covered in the Contract Documents will be required if it is consistent therewith and is reasonably inferable therefrom as being necessary to produce the intended results. In case of a discrepancy between the Drawings and Specifications or among Drawings, the strongest, the larger quantity or better quality, as determined by the Interpreter shall govern. If an item is shown on the Drawings, but not specified, the Contactor shall provide the item of a quality similar to other items specified, as determined by the Interpreter. If an item is specified, but not shown on the Drawings, it shall be located as required by the Interpreter.

B. Wind Load: Provide products designed to withstand the indicated wind load; when requested, submit substantiating data.

C. Fire Resistance Rating: Provide materials and assemblies which have been tested and listed by UL, FM, IRI, OIA, or other recognized authority, for the assembly shown or specified; where specified, attach label of testing authority. For oversized assemblies or assemblies similar to those tested, provide Manufacturer's certification that the assembly has been constructed of materials and methods equivalent to the tested construction.

D. Flame Spread Rating: Provide products with the indicated flame spread rating or less; when requested, submit substantiating data. Provide materials with flame spread ratings required by code, unless a more strict requirements is specified.

E. Proprietary Products: Where systems or assemblies of materials or equipment are indicated, obtain all primary components from the same Manufacturer, unless specifically noted otherwise.

1.3 TESTING LABORATORY

A. The Owner shall coordinate and provide all testing services, including soil testing and concrete testing, except that which may be specifically specified otherwise in the technical sections.

1.4 INSPECTION SERVICES

A. Perform or arrange for all inspections, tests, and approvals required in each Technical Section or by governing authority.

B. Pay all costs unless specifically stated otherwise in the Technical Sections.

C. Notify each inspecting authority, Engineer, and Owner 24 hours in advance of each test, inspection and approval.

D. Keep records of each test, inspection and approval. Include the time, weather conditions, name of inspecting, testing, or approving authority, results of the test, and all other pertinent data.

E. Submit official reports showing dates performed, test methods, results, interpretations of results, and recommended actions. Submit required copies to governing authorities, Engineer, and Owner.

F. Provide required certificates to Engineer and Owner for the Owner's file.

G. If Engineer determines that any work requires special inspection, testing, or approval he will, upon written authorization from Owner, instruct Contractor to order such special inspection, testing, or approval. If such special inspection or testing reveals a failure of the work to comply with requirements of the Contract Documents, Contractor shall bear all costs thereof, including compensation for additional services of Engineer; otherwise, Owner shall bear such costs, and an appropriate Change Order shall be issued.

1.5 CONTRACTOR'S QUALITY CONTROL

A. Temperature and Humidity
   1. Maintain a daily log of outdoor and indoor high/low temperatures and general weather conditions. Such log shall be readily accessible to Engineer.
   2. Provide accurate outdoor and indoor thermometers at the Site.
   3. Do not install products in or on structures in temperatures or moisture conditions outside the recommended ranges.
   4. Maintain proper ambient and material temperatures and moisture conditions as required by product Manufacturers and other standards, by use of temporary heat, ventilation, construction of temporary structures, or by other approved means.
   5. If low temperatures make it impossible to continue operations safely, in spite of cold weather precautions, cease Work and notify Engineer.
   6. Where a substrate or product is recommended to be dry or a moisture content is listed for installation procedures, conform to the requirements. If actual conditions do not meet the standards, reduce moisture in products or substrate by approved artificial methods when natural processes would delay the progress of the Work.

B. Power Characteristics
   1. Refer to Division 26 for project power characteristics.
   2. Motors, starters, safety switches, pushbuttons, pull cords, internal wiring and operating devices, and low voltage wiring are the responsibility of each Contractor providing a product requiring electrical service.
   3. All conduit, wiring, and interlocking required to complete the installation are the responsibility of the Electrical Contractor.

1.6 MANUFACTURER'S FIELD SERVICES

A. General
   1. When indicated in the technical specifications, provide a qualified technical representative at the Site to advise on the proper installation of the product.

2. Representative shall check the installation of the equipment, supervise its initial operation and initial testing and instruct operating personnel in its operation and maintenance.
3. Representative shall supervise necessary adjustments to insure satisfactory operation.
4. Some of the technical sections require a minimum number of hours or days for the Representative to remain on the Site. This time must fall within the normal construction day. If a longer time or overtime is required it shall be provided at no increase in cost to the Owner.
5. Representative shall remain on the Site or make as many return visits as necessary to insure the equipment is operating properly.
6. If the service includes coordination, calibration, etc. with another Manufacturer's connecting equipment, the Contractor shall arrange for those Representatives involved to be on the Site at the same time.
7. Where the supervision of a Representative is not called for in the technical specifications, this shall in no way relieve the Contractor of his responsibility to properly construct or install equipment or material in accordance with the Contract Documents.
8. Contractor shall make arrangements with the Representative and notify Engineer at least five days in advance of each visit.
9. Report Form: Where a Report Form is required in the Technical Specifications, the Representative shall complete and submit a "Manufacturer's Service Representative's Report" using the form attached at the end of this Section. A separate Report shall be required for each piece of equipment and each visit. Contractor shall submit 3 copies of the signed Report Form within 5 days of the visit. Contractor shall furnish all necessary copies of the attached form.

B. Training
1. For major pieces of equipment and SCADA systems, there shall be training session(s) provided by the manufacturer or Contractor.
2. An outline shall be provided showing, as a minimum, basic function, start-up procedures, normal operating procedures, and normal maintenance.
3. The Contractor shall record video, with audio, each session. There shall be a separate DVD or other electronic video media for each piece of equipment, unless otherwise noted or approved.

1.7 CONTRACTOR DESIGN RESPONSIBILITIES

A. The design of all pre-engineered elements, assemblies, components and connections of all types not designed by the Engineer shall be the total responsibility of the Contractor. Such shall include, but shall not be limited to, structural steel, precast concrete, wall panels, windows, architectural items, mechanical items, and electrical items. Engineering required for such for which all or a portion of the necessary engineering services are performed by the Manufacturer shall be the total responsibility of the Contractor. Where the Contract Documents require the design of architectural, structural, mechanical, or electrical items by a supplier, or where a Contractor initiates a change in the design of a system or component thereof, such design shall be the total responsibility of the Contractor.

B. All Contractor design responsibilities shall be performed by a Registered Professional Engineer. Submit all calculations to Engineer for his records as a Reference Submittal prior to starting fabrication or installation of the Work. Engineer shall not review, check, or approve such submittals. Engineer will not be responsible for designs of others, including those of the Contractor, Subcontractors, and suppliers.

1.8 JOB CONDITIONS

A. Existing Conditions
   1. Condition of existing Structure and Site will be maintained as far as possible by the Owner up to the time the Work commences. However, variations may occur after inspection of the premises by the Bidder, due to Owner's removal and salvage operations. Owner assumes no responsibility for actual conditions at the time Work commences.
   2. Execute Work in connection with the existing building, as indicated. Report any marked discrepancy between the Drawings and actual conditions at the Building to Engineer or adjustment.
   3. All material removed by the Contractor unless otherwise specified, becomes his property and shall be removed from the premises promptly.

1.9 FAULTY AND NON-CONFORMING WORK

A. Faulty work or work not in conformance with the Contract Documents shall not be permitted.

B. Remove such work or propose a remedy by means of detailed drawings and written documentation and submit such documentation to the Engineer for his comments.

C. All costs for removal and reconstruction of such work, and additional services of the Engineer shall be paid by the Contractor. Payments for such additional services of the Engineer shall be made as follows:
   1. Owner will compensate Engineer.
   2. Owner will deduct the amount of such compensation from payments to the Contractor.

END OF SECTION 01 4500

SECTION 01 4516

FIELD QUALITY CONTROL PROCEDURES

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 FIELD MEASUREMENTS

A. Make field measurements wherever possible for accurate fabrication of built-in or attached products. Do not delay job progress. Allow for trimming where field measurements cannot be made prior to fabrication.

1.3 LAYOUT

A. Establish bench marks and layouts as required, from the information indicated on the Drawings. Extend these lines up through the Building as the work progresses. Each Subcontractor shall lay out his work from these references.

B. Protect control points prior to starting site work and preserve all permanent reference points during construction.
   1. Make no changes or relocations without prior written notice to Engineer.
   2. Report to Engineer when any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations.
   3. Require surveyor to replace project control points which may be lost or destroyed.
      a. Establish replacements based on original survey control.

1.4 PROJECT SURVEY REQUIREMENTS

A. Establish lines and levels, locate and lay-out, by instrumentation and similar appropriate means:
   1. Site Improvements such as utility alignment and elevations.
   2. Foundation locations and floor levels.

1.5 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

1.6 SUBMITTALS

A. On request of the Engineer, submit documentation to verify the accuracy of field engineering work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 4516

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SECTION 01 4533

CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope
   1. Contractor shall provide labor, materials, tools, equipment, and incidentals as shown, specified, and required to cooperate with the Coordinating Special Inspector, individual special inspectors, and testing agencies employed by Owner, to facilitate Special Inspections.
   2. Supplement A, Statement of Special Inspections, included with this Section, lists testing and inspections required.

1.2 DEFINITIONS

A. Agencies and Personnel:
   1. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services. An approved agency shall provide all information necessary to the Building Official to determine that the agency meets the applicable requirements.
   2. Building Official: Officer or other designated authority having jurisdiction charged with the administration and enforcement of the governing building code, or a duly authorized representative.
   3. Coordinating Special Inspector: Professional Engineer or architect, hired by Owner, registered in the same state as the Site, responsible for coordinating and verifying the inspection and testing required by the Statement of Special Inspections included in this Section and reporting to the Building Official and the Registered Design Professional in Responsible Charge.
   4. Registered Design Professional in Responsible Charge: A registered design professional, registered in the same state as the Site, engaged by the Owner to review and coordinate certain aspects of the project, as determined by the Building Official, for compatibility with the design of the building or structure and the requirements of the contract documents, including submittal documents prepared by others, deferred submittal documents and phased submittal documents. The Registered Design Professional in Responsible Charge may serve as the Coordinating Special Inspector.
   5. Registered Design Professional: An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the Project is to be constructed.
   6. Special Inspector: Qualified person employed or retained by an Approved Agency or Owner, and approved by the Building Official as having the competence necessary to inspect a particular type of construction requiring Special Inspection.

B. Special Inspection:
   1. Special Inspection: Owner furnished inspection of construction requiring the expertise of an approved Special Inspector to ensure compliance with approved Contract Documents and referenced standards as required by the IBC.

2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present when and where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of work requiring Special Inspection by an approved Special Inspector who is present in the area where the Work has been or is being performed.

C. Statement of Special Inspection:
1. Detailed written procedure contained in the Supplement to this Section establishing systems and components subject to Special Inspection, Observation, and Testing.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Owner will employ and pay for services of the Coordinating Special Inspector, who will have not less than five years of experience in managing, monitoring, and inspecting building construction.
2. Special Inspectors and Approved agencies will be qualified in their assigned Special Inspection in accordance with Supplement A, Statement of Special Inspections, of this Section or to the satisfaction of the Building Official.

B. Regulatory Requirements:
1. Special Inspections will be in accordance with applicable building code and other Laws and Regulations, and Supplement A, Statement of Special Inspections, of this Section.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Samples: Representative Samples of materials when required by Engineer.

B. Informational Submittals: Submit the following:
1. Completed Supplement C, Fabricator's Certificate of Compliance, as attached to this Section, for fabrication of structural elements and assemblies.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Provide safe access to the Work to be tested and inspected.

B. Provide assistance in obtaining and handling test samples at the Site.

C. Facilitate inspections and tests.

D. Provide access to Suppliers' and Subcontractors' operations as required.

E. Notify Coordinating Special Inspector and Engineer no less than 48 hours in advance of the Work for the Coordinating Special Inspector and Engineer to coordinate their personnel at the Site. Do not cover the Work to be inspected until Special Inspection has been completed and the results thereof are acceptable.

F. Special Inspections required in this Section do not supersede or make unnecessary inspections and tests required under other Specification Sections or standard inspections required by Laws and Regulations.

1.6 COORDINATING SPECIAL INSPECTOR'S RESPONSIBILITIES

A. Coordinating Special Inspector will:
   1. Engage services of inspectors and testing agencies for Special Inspections in accordance with Supplement A, Statement of Special Inspections, of this Section and as required by Laws and Regulations.
   2. Coordinate activities of individual inspectors and testing agencies with Contractor.
   3. Provide interim reports of inspections and material testing to Building Official, Owner, Registered Design Professional in Responsible Charge, and Engineer.
   4. To obtain certificate of use and occupancy from the Building Official, complete, stamp, sign, and provide to the Building Official, Owner, Registered Design Professional in Responsible Charge, and Engineer Supplement B, Final Report of Special Inspections, of this Section, documenting completion of Special Inspections and correction of discrepancies noted in the Special Inspections.

1.7 INSPECTOR RESPONSIBILITIES

A. Perform specified inspections, sampling, and testing of materials and methods of construction; review and ascertain compliance with Laws and Regulations.

B. Promptly notify Coordinating Special Inspector, Owner, Engineer and Contractor of irregularities or deficiencies in the Work observed during Special Inspections. Corrective action, if required, will be determined by Engineer.

C. Promptly submit two copies of each report of inspections and tests to Coordinating Special Inspector, Engineer, and Contractor including:
   1. Date issued.
   2. Project title and number.
   3. Name and signature of inspector.
   4. Date of inspection or sampling and test.
   5. Record of temperature and weather.
   6. Identification of product and Specification Section.
   7. Location in Project.
   8. Type of inspection or test.
   9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.

D. At the end of construction, each inspector and testing agency shall prepare a Special Inspector Final Report which is included in Supplement B.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SUPPLEMENTS

A. The supplements listed below, following the "End of Section" designation, are part of this Section:
   1. Supplement A – Statement of Special Inspections
   2. Supplement B – Final Report of Special Inspections
   3. Supplement C – Fabricator's Certificate of Compliance

END OF SECTION 01 4533

Supplement A
Statement of Special Inspections

Statement of Special Inspections Submittal Form

In compliance with 2015 IBC

Project: **Richard Renneker WTP Membrane Softening Upgrades**

Location: **Richard Renneker WTP 6193 Striker Rd, Maineville Ohio 45039**

Owner: **Warren County, Ohio**

Structural Engineer of Record: **Imelda Cauley, PE**

This *Statement of Special Inspections* is submitted as a condition for permit issuance in accordance with Special Inspection and Structural Testing requirements of the 2017 Ohio Building Code section 1704.
If applicable, *Statement of Special Inspections* includes *Requirements for Seismic Resistance* and/or *Requirements for Wind Resistance*:

Are *Requirements for Seismic Resistance* required to be included in the *Statement of Special Inspections*? – IBC 1704.6.1 ☐ Yes ☒ No

Are *Requirements for Wind Resistance* required to be included in the *Statement of Special Inspections*? – IBC 1704.6.2 ☐ Yes ☒ No

The Coordinating Special Inspector shall keep records of all inspections and shall furnish inspection reports to the Building Official and the Registered Design Professional in Responsible Charge. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Registered Design Professional in Responsible Charge. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

A Final Report of *Special Inspections* documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted to the Building official prior to issuance of a Certificate of Use and Occupancy.

Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Statement of Special Inspection prepared by: Imelda Cauley, P.E.

Statement of Special Inspections

This statement of special inspections has been developed specifically for the RARWTP Membrane Softening Upgrades.

The Statement of Special Inspections provides project compliance with the provisions of the 2017 Ohio Building Code (OBC) Chapter for Special Inspection, Professional Observation, and Testing.

SYSTEM OR MATERIAL	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
SOILS							
1. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY	1705.6		SECTION 31 2305, EXCAVATION AND FILL	X		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL Engineer SERVING AS SPECIAL INSPECTOR
2. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL	1705.6		SECTION 31 2305, EXCAVATION AND FILL	X		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL Engineer SERVING AS SPECIAL INSPECTOR
3. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS	1705.6		SECTION 31 2305, EXCAVATION AND FILL	X		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL Engineer SERVING AS SPECIAL INSPECTOR
4. VERIFY USE OF PROPER MATERIALS, DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL	1705.6		SECTION 31 2305, EXCAVATION AND FILL		X	X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL Engineer SERVING AS SPECIAL INSPECTOR

SYSTEM OR MATERIAL	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
5. PRIOR TO PLACEMENT OF COMPACTED FILL, INSPECT SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY	1705.6		SECTION 31 2305, EXCAVATION AND FILL	X		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER SERVING AS SPECIAL INSPECTOR

BUILDING MECHANICAL							
1. INSTALLATION OF SMOKE CONTROL SYSTEMS							
A. PENETRATION FIRESTOPS	1705.17.1	UL LISTING ASTM E2174	SECTION 07 2105 BUILDING INSULATION		X	X	CONDUCTED BY APPROVED AGENCY IN ACCORDANCE WITH ASTM E2174.
B. FIRE RESISTANT JOINT SYSTEMS	1705.17.1	UL LISTING ASTM E2393	SECTION 07 2105 BUILDING INSULATION		X	X	CONDUCTED BY APPROVED AGENCY IN ACCORDANCE WITH ASTM E2393.
GENERAL							
1. INSTALLATION OF MATERIALS THAT REQUIRE ADDITIONAL MANUFACTURER'S INSTRUCTIONS BEYOND CODE REQUIREMENTS	1703.4.2,1704.3	ICC-ES EVALUATION REPORTS	SECTION 05 0533 ANCHOR SYSTEMS		X		ANCHORS INSTALLED IN HARDENED CONCRETE. VERIFY PRODUCT SPECIFIC ICC-ES REPORT SPECIAL INSPECTION AND PROJECT SPECIFIC REQUIREMENTS ARE PROVIDED.

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
CONCRETE CONSTRUCTION							
1. INSPECTION OF REINFORCING STEEL, INCLUDING PRESTRESSING TENDONS, AND PLACEMENT	1705.3	ACI 318: Ch. 20, 25.2, 25.3, 26.5.1-26.5.3	SECTION 03 2000 CONCRETE REINFORCING	X		X	
2. REINFORCING BAR WELDING:							NOT ALLOWED UNLESS APPROVED BY ENGINEER. SEE STEEL CONSTRUCTION FOR WELDING INSPECTION REQUIREMENTS
A. VERIFY WELDABILITY OF REINFORCING BARS OTHER THAN ASTM A706.	1705.3	AWS D1.4 ACI 318: 26.5.4	SECTION 03 2000 CONCRETE REINFORCING	X			
B. INSPECT SINGLE PASS FILLET WELDS, MAXIMUM 5/6”	1705.3	AWS D1.4 ACI 318: 26.5.4	SECTION 03 2000 CONCRETE REINFORCING	X			
C. INSPECT ALL OTHER WELDS	1705.3	AWS D1.4 ACI 318: 26.5.4	SECTION 03 2000 CONCRETE REINFORCING		X		

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
3. INSPECT ANCHORS CAST IN CONCRETE	1705.3	ACI 318: 17.8.2	SECTION 05 0533 ANCHOR SYSTEMS	X		X	
4. INSPECT ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS							
A. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED ORIENTATIONS TO RESIS SUSTAINED LOADS	1705.3	ACI 318: 17.8.2.4	SECTION 05 0533 ANCHOR SYSTEMS		X	X	
B. MECHANICAL ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 4A.	1705.3	ACI 318: 17.8.2	SECTION 05 0533 ANCHOR SYSTEMS	X		X	
5. VERIFY USE OF REQUIRED DESIGN MIX	1705.3	ACI 318: Ch. 19, 26.4.3, 26.4.4	SECTION 03 3000 CAST-IN-PLACE CONCRETE	X		X	
6. PRIOR TO CONCRETE PLACEMENT, FABRICATE SPECIMENS FOR STRENGTH TESTS, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE.	1705.3	ASTM C 172, ASTM C 31, ACI 318: 26.4.5, 26.12	SECTION 03 3000 CAST-IN-PLACE CONCRETE		X	X	

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
7. INSPECT CONCRETE AND SHOTCRETE PLACEMENT FOR PROPER APPLICATION TECHNIQUES	1705.3	ACI 318: 26.4.5	SECTION 03 3000 CAST-IN-PLACE CONCRETE		X	X	
8. VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES	1705.3	ACI 318: 26.4.7-26.4.9	SECTION 03 3000 CAST-IN-PLACE CONCRETE	X		X	
9. INSPECTION OF PRESTRESSED CONCRETE							
A. APPLICATION OF PRESTRESSING FORCES	1705.3	ACI 318: 26.10	SECTION 03 4113		X	X	PER OBC 1704.2.2, PCI CERTIFICATION IN LIEU OF CONTINUOUS SPECIAL INSPECTION IS ACCEPTABLE
B. GROUTING OF BONDED PRESTRESSING TENDONS	1705.3	ACI 318: 26.8	SECTION 03 4113		X	X	PER OBC 1704.2.2, PCI CERTIFICATION IN LIEU OF CONTINUOUS SPECIAL INSPECTION IS ACCEPTABLE

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
10. ERECTION OF PRECAST CONCRETE MEMBERS	1705.3	ACI 318: 26.8	SECTION 03 4113		X	X	
11. VERIFY IN-SITU CONCRETE STRENGTH, PRIOR TO STRESSING OF TENDONS IN POST-TENSIONED CONCRETE AND PRIOR TO REMOVAL OF SHORING AND FORMS FROM BEAMS AND STRUCTURAL SLABS	1705.3	ACI 318: 26.10.2	SECTION 03 1100 CONCRETE FORMING	X		X	
12. INSPECT FORMWORK FOR SHAPE, LOCATION AND DIMENSIONS OF THE CONCRETE MEMBER BEING FORMED	1705.3	ACI 318: 26.10.1(b)	SECTION 03 1100 CONCRETE FORMING	X		X	
MASONRY							
1. VERIFY COMPLIANCE WITH APPROVED SUBMITTALS	1705.4	ACI 530: Table 3.1.2; ACI 530.1 Art. 1.5	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
2. AS MASONRY CONSTRUCTION BEGINS, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:							
A. PROPORTIONS OF SITE-PREPARED MORTAR	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 2.1, 2.6	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
B. CONSTRUCTION OF MORTAR JOINTS	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 3.3B	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
C. GRADE AND SIZE OF PRESTRESSING TENDONS AND ANCHORAGES				NOT APPLICABLE			
D. LOCATION OF REINFORCEMENT, CONNECTORS, AND PRESTRESSING TENDONS AND ANCHORAGES	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 3.4, 3.6A	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
E. PRESTRESSING TECHNIQUE				NOT APPLICABLE			
F. PROPERTIES OF THIN BED MORTAR FOR AAC MASONRY				NOT APPLICABLE			
3. PRIOR TO GROUTING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:							

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
A. GROUT SPACE	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 3.2D, 3.2F	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
B. GRADE, TYPE, AND SIZE OF REINFORCEMENT AND ANCHOR BOLTS, AND PRESTRESSING TENDONS AND ANCHORAGES	1705.4	ACI 530: Table 3.1.2, Sec 6.1; ACI 530.1-Art 2.4, 3.4	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
C. PLACEMENT OF REINFORCEMENT, CONNECTORS, AND PRESTRESSING TENDONS AND ANCHORAGES	1705.4	ACI 530: Table 3.1.2, Sec 6.1,6.2.1, 6.2.6, 6.2.7; ACI 530.1-Art 3.2E, 3.4, 3.6A	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
D. PROPORTIONS OF SITE-PREPARED GROUT AND PRESTRESSING TENDONS AND ANCHORAGES	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 2.6B, 2.4.G.1b	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
E. CONSTRUCTION OF MORTAR JOINTS	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 3.3B	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
4. VERIFY DURING CONSTRUCTION:							
A. SIZE AND LOCATION OF STRUCTURAL ELEMENTS	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 3.3F	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
B. TYPE, SIZE, AND LOCATION OF ANCHORS, INCLUDING OTHER DETAILS OF ANCHORAGE TO MASONRY TO STRUCTURAL MEMBERS, FRAMES, OR OTHER CONSTRUCTION	1705.4	ACI 530: Table 3.1.2; Sec. 1.2.1(e), 6.1.4.3, 6.2.1	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
C. WELDING OF REINFORCEMENT	1705.4	ACI 530: Table 3.1.2; Sec. 8.1.6.7.2,9.3.3.4(c) 11.3.3.4(b)	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	NOT ALLOWED UNLESS APPROVED BY Engineer. SEE STEEL CONSTRUCTION FOR WELDING INSPECTION REQUIREMENTS
D. PREPARATION, CONSTRUCTION, AND PROTECTION OF MASONRY DURING COLD WEATHER (TEMPERATURE BELOW 40 DEG F OR HOT WEATHER (TEMPERATURE ABOVE 90 DEG F.	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 1.8C, 1.8D	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
E. APPLICATION AND MEASUREMENT OF PRESTRESSING FORCE				NOT APPLICABLE			

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
F. PLACEMENT OF GROUT AND PRESTRESSING GROUT FOR BONDED TENDONS IS IN COMPLIANCE	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 3.5, 3.6C	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
5. OBSERVE PREPARATION OF GROUT SPECIMENS, MORTAR SPECIMENS, AND OR/PRISMS	1705.4	ACI 530: Table 3.1.2; ACI 530.1-Art 1.4.B.2.a.3, 1.4.B.2.b.3, 1.4.B.2.c.3, 1.4.B.3, 1.4.B.4	SECTION 04 0511 UNIT MASONRY CONSTRUCTION	X		X	
STRUCTURAL STEEL							
1. SPECIAL INSPECTION OF THE FABRICATION PROCESS OF PREFABRICATED STEEL STRUCTURAL ELEMENTS AND ASSEMBLIES.							
A. FABRICATION AND IMPLEMENTATION PROCEDURES	1704.2.5		SECTION 05 1200, STRUCTURAL STEEL FRAMING	X		X	REVIEW OF FABRICATOR'S WRITTEN PROCEDURAL AND QUALITY CONTROL MANUALS AND PERIODIC AUDITING OF FABRICATION PRACTICES BY AN APPROVED SPECIAL INSPECTION AGENCY. -OR- AISC CERTIFICATION

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
B. MANUFACTURER'S CERTIFICATE OF COMPLIANCE REQUIRED	1704.2.5, AISC 360, N2.		SECTION 05 1200, STRUCTURAL STEEL FRAMING		X	X	
2. PRIOR TO WELDING							
A. VERIFY WELDING PROCEDURES (WPS) AND CONSUMABLE CERTIFICATES	1705.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X	X	
B. MATERIAL IDENTIFICATION (TYPE/GRADE)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X		X	
C. WELDER IDENTIFICATION SYSTEM	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X		X	A SYSTEM SHALL BE MAINTAINED BY WHICH A WELDER WHO HAS WELDED A JOINT CAN BE IDENTIFIED.
D. FIT-UP GROOVE WELDS (INCLUDING JOINT GEOMETRY)							
1) JOINT PREPARATION	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
2) DIMENSIONS (ALIGNMENT, ROOT OPENING, ROOT FACE, BEVEL)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
3) CLEANLINESS (CONDITION OF STEEL SURFACES)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
4) TACKING (TACK WELD QUALITY AND LOCATION)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
5) BACKING TYPE AND FIT (IF APPLICABLE)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
E. CONFIGURATION AND FINISH OF ACCESS HOLES	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
F. FIT UP OF FILLET WELDS							
1) DIMENSIONS (ALIGNMENT, GAPS AT ROOT)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
2) CLEANLINESS (CONDITION OF STEEL SURFACES)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
3) TACKING (TACK WELD QUALITY AND LOCATION)	1704.2.1	AISC 360: Table N5.4-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
3. DURING WELDING							
A. USE OF QUALIFIED WELDERS	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
B. CONTROL AND HANDLING OF WELDING CONSUMABLES							
1) PACKAGING	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
2) EXPOSURE CONTROL	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
C. NO WELDING OVER CRACKED TACK WELDS	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
D. ENVIRONMENTAL CONDITIONS							
1) WIND SPEED LIMITS	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
2) PRECIPITATION AND TEMPERATURE	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
E. WPS FOLLOWED							

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
1) SETTINGS ON WELDING EQUIPMENT	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
2) TRAVEL SPEED	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
3) SELECTED WELDING MATERIALS	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
4) SHIELDING GAS TYPE/FLOW RATE	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
5) PREHEAT APPLIED	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
6) INTERPASS TEMPERATURE MAINTAINED	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
7) PROPER POSITION (F,V,G,OH)	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
F. WELDING TECHNIQUES							
1) INTERPASS AND FINAL CLEARING	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
2) EACH PASS WITHIN PROFILE LIMITATIONS	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
3) EACH PASS MEETS QUALITY REQUIREMENTS	1704.2.1	AISC 360: Table N5.4-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
4. AFTER WELDING							
A. WELDS CLEANED	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
B. SIZE AND LOCATION OF WELDS	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
C. WELDS MEET VISUAL ACCEPTANCE CRITERIA							
1) CRACK PROHIBITION	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
2) WELD/BASE METAL FUSION	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
3) CRATER CROSS SECTION	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
4) WELD PROFILES	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
5) WELD SIZE	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
6) UNDERCUT	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
7) POROSITY	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
D. ARC STRIKES	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
E. k-AREA	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
F. BACKING REMOVED AND WELD TABS REMOVED (IF REQUIRED)	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
G. REPAIR ACTIVITIES	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
H. DOCUMENT ACCEPTANCE OR REJECTION OF WELDED JOINT OR MEMBER	1704.2.1	AISC 360: Table N5.4-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
5. PRIOR TO BOLTING							
A. MANUFACTURER'S CERTIFICATION AVAILABLE FOR FASTENER MATERIALS	1704.2.1	AISC 360: Table N5.6-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
B. FASTENERS MARKED IN ACCORDANCE WITH ASTM REQUIREMENTS	1704.2.1	AISC 360: Table N5.6-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
C. PROPER FASTENER SELECTED FOR THE JOINT DETAIL (GRADE, TYPE, BOLT LENGTH IF THREADS EXCLUDED FORN THE SHEAR PLANE)	1704.2.1	AISC 360: Table N5.6-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
D. PROPER BOLTING PROCEDURE SELECTED FOR JOINT DETAIL	1704.2.1	AISC 360: Table N5.6-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
E. CONNECTING ELEMENTS, INCUDING THE APPROPRIATE FAYING SURFACE CONDITION AND HOLE PREPARATION, IF SPECIFIED, MEETS THE APPLICABLE REQUIREMENTS.	1704.2.1	AISC 360: Table N5.6-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
F. PRE-INSTALLATION VERIFICATION TESTING BY INSTALLATION PERSONNEL OBSERVED AND DOCUMENTED FOR FASTENER ASSEMBLIES AND METHODS USED	1704.2.1	AISC 360: Table N5.6-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
G. PROPER STORAGE PROVIDED FOR BOLTS, NUTS, WASHERS, AND OTHER FASTENER COMPONENTS.	1704.2.1	AISC 360: Table N5.6-1	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		
6. DURING BOLTING							
A. FASTENER ASSEMBLIES, OF SUITABLE CONDITION, PLACED IN ALL HOLES AND WASHERS (IF REQUIRED) ARE POSITIONED AS REQUIRED.	1704.2.1	AISC 360: Table N5.6-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			

SYSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS
B. JOINT BROUGHT TO THE SNUG-TIGHT CONDITION PRIOR TO THE PRETENSIONING OPERATION	1704.2.1	AISC 360: Table N5.6-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
C. FASTENER COMPONENT NOT TURNED BY THE WRENCH PREVENTED FROM ROTATING	1704.2.1	AISC 360: Table N5.6-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
D. FASTENERS ARE PRETENSIONED IN ACCORDANCE WITH RCSC SPECIFICATION, PROGRESSING SYSTEMATICALLY FROM THE MOST RIGID POINT TOWARD THE FREE EDGES	1704.2.1	AISC 360: Table N5.6-2	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
7. AFTER BOLTING							
A. DOCUMENT ACCEPTANCE OR REJECTION OF BOLTED JOINTS	1704.2.1	AISC 360: Table N5.6-3	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			
8. OTHER INSPECTION TASKS							
A. ANCHOR RODS AND OTHER EMBEDMENTS SUPPORTING STEEL	1704.2.1	AISC 360: SECTION N5.7	SECTION 05 1200, STRUCTURAL STEEL FRAMING		X		

YSTEM	2017 OBC CODE REFERENCE	REFERENCED STANDARD	REFERENCE SPECIFICATION SECTION	PERIODIC Owner FURNISHED SPECIAL INSPECTION	CONTINUOUS Owner FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COM
TED STEEL OR D FRAME	1704.2.1	AISC 360: SECTION N5.7	SECTION 05 1200, STRUCTURAL STEEL FRAMING	X			VERIFY COMPL WITH T DETAIL ON THE CONST DOCUM SUCH A STIFFE MEMBE LOCAT PROPE APPLIC JOINT D AT EAC CONNE

WOOD CONSTRUCTION (NOT IN CONTRACT)

C INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURIN ENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THA CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING.

Supplement B
Final Report of Special Inspections

Final Report of Special Inspections

Project: RARWTP Membrane Softening Upgrades

Location: Richard Renneker WTP 6193 Striker Rd, Maineville Ohio 45039

Owner: Warren County, Ohio

Structural Engineer of Record: Imelda Cauley, PE

To the best of my information, knowledge and belief, the Special Inspections required for this project, and itemized in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)
Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,
Coordinating Special Inspector

_____
(Type or print name)

_____
Signature Date

Licensed Professional Seal

Special Inspector Final Report

Project: RARWTP Membrane Softening Upgrades

Special Inspector:

Coordinating Special Inspector:

To the best of my information, knowledge and belief, the Special Inspections or testing required for this project, and designated for this Agent in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)
Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,
Special Inspector

(Type or print name)

Signature Date

Licensed Professional Seal or *Certification*

Supplement C
Fabricator's Certificate of Compliance

Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section 1704.2 of the 2017 Ohio Building Code must submit a *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project: RARWTP Membrane Softening Upgrades

Fabricator's Name:

Address:

Certification or Approval Agency:

Certification Number:

Date of Last Audit or Approval:

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with the Contract Documents.

_____ _____

Signature Date

_____

Title

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

SECTION 01 5000

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 1 apply to the work of all other sections.

1.2 GENERAL

A. Provide and maintain as a minimum the temporary facilities described herein. Locate all facilities where approved by Engineer and remove same at completion of the work or when otherwise directed.

B. Comply with all laws, regulations, and safe practices.

C. Provide temporary utilities throughout construction period as required to facilitate progress of work, to protect work, to provide safe and adequate working conditions throughout Project, to provide for public safety, and to meet all construction needs.

D. Temporary utilities include, but are not limited to, temporary electricity, lighting, telephone, water, toilets, enclosures, signs, and traffic control.

E. Remove all temporary utilities, repair all damage caused in installation and restore to existing condition.

F. Codes and Standards
   1. National Electric Code (ANSI C1); National Electric Safety Code; Federal and State requirements; Utility company regulations; Ohio Department of Transportation.

1.3 TEMPORARY UTILITIES

A. Monitor Temporary Utilities
   1. Any party designated to provide a temporary utility shall be responsible for all damage to his work or to that of other Contractors caused by a defect in such utility.
      a. Enforce compliance with applicable codes and standards
      b. Enforce safe practices
      c. Prevent abuse of services and utilities
      d. Prevent damage to finishes
   2. Do not allow wasteful use of consumables
   3. Contractor to be responsible for cost of all cosumables used by Engineer during the project including copy/print paper, toner and ink cartridges.
   4. Contractor to be responsible for maintaining personal computer and printer during contract period. This includes all service, up to, and including, replacement of defective equipment. If the computer supplied for the Engineer’s use will be unavailable for more than two days due to repair/service, a comparable computer will be supplied by the Contractor for use.

PART 2 PRODUCTS

2.1 MATERIALS

A. May be new or used, but must be adequate for the intended purpose.

B. Must not create unsafe or unsanitary conditions nor violate requirements of applicable Codes.

C. Comply with applicable Federal and State regulations.

2.2 FACILITIES

A. Telephone
   1. Permanent type phone and/or cell phone.
   2. Number Required: One for the Engineer's field office on the same line.
   3. Directories
      a. Provide one alphabetical and one classified directory of telephone service company at each instrument.
      b. Provide project directory at Engineer's field office and General Contractor's field office listing name and business telephone number of:
         1) Each Contractor and Subcontractor
         2) Each Supplier
         3) Engineer
         4) Construction Manager
         5) Professional consultants
         6) Owner
         7) Testing laboratories
         8) Regulatory agencies, with inspector's names
         9) Medical services:
            a) Physicians
            b) Hospitals
            c) Ambulance service companies
         10) Fire Department
         11) Police Department

B. Temporary Toilets
   1. Equipment: Standard products, meeting code requirements.
   2. Toilet Facilities: Self ventilated portable toilets, either:
      a. Privies
      b. Chemical toilets
      c. Recirculating toilets, or
      d. Combustion toilets
   3. Toilet Tissue: Provide at each toilet, on suitable dispenser, with adequate reserve supply. Monitor daily.

C. Field Offices
   1. Contractor's Office: Provide a weathertight office of sufficient size and facilities to accommodate Contractor's field personnel, his subcontractors, job meetings, storage of field documents, layout space for Drawings, drafting table for production of As-Built Drawings.
   2. Engineer's Office: Provide a heated/air-conditioned office with a lockable door, desk (about 3' x 5'), chair, table (about 3' x 5'), and internet. This office can be a separate room in the Contractor's Office.

D. Project Sign
   1. Provide and install a project sign, or signs, with minimum requiremnts as noted below.
   2. The sign(s) supplied on the Project must meet the requirements of the funding agencies involved.
   3. The sign shall be 4'x8', weatherproof construction and in color. It shall be securely mounted and installed in a manner to last throughout the Contract period.
   4. Any permits required for the installation of the sign shall be obtained by the Contractor.
   5. The sign shall contain the information shown below with the actual layout and materials being approved.

Owner: _____
Project: _____
Engineer: _____
Contractor: _____
Funding Assistance: _____
Contract Amount: _____

E. Traffic Control Devices: Comply with the Manual of Uniform Traffic Control.

PART 3 EXECUTION

3.1 GENERAL

A. Comply with applicable Federal and State regulations.

B. Install work in neat and orderly manner.

C. Make structurally, mechanically, and electrically sound throughout.

D. Maintain to give safe, continuous services and to provide safe working conditions.

E. Modify and extend systems as work progress requires.

3.2 FACILITIES

A. Telephones
   1. Provide 2-way communication between Contractor and Engineer's field representative, either by phone or radio.

B. Temporary Toilets
   1. Erect securely, anchor to prevent dislocation.
   2. Service as often as necessary to prevent accumulation of wastes and creation of unsanitary conditions.
   3. Provide the following minimum number of approved enclosed combination toilet and urinal units for construction personnel:
      a. For less than 20 workers: 1.
      b. For 20 or more workers: 2 per 40 workers.
   4. Location
      a. Within the project site.
      b. Secluded from public observation.
      c. Obtain acceptance of locations by the Engineer.
   5. Enclosures for Toilet Facilities
      a. Weatherproof, sightproof, sturdy temporary enclosures.
      b. Ventilated to meet applicable Federal and State requirements.
      c. For enclosures accommodating two or more persons, provide privacy screens for each toilet fixture.

C. Field Offices
   1. General
      a. Locate as approved by Engineer.
      b. All offices must be tied down to resist high winds.
   2. Engineer's Office
      a. Provide parking space for vehicles.
      b. Sweep floors and dust at least once a week.
      c. Clean windows at least once a month.
      d. Maintain supplies, including drinking water.

D. Project Sign: Locate sign as directed by the Engineer.

E. Traffic Control Devices
   1. Contractor shall develop and submit for approval, a general traffic control plan for the project.
   2. Specifics of the traffic control plan shall conform to the Ohio Manual of Uniform Traffic Control Devices.
   3. It may be required to modify the specifics of the traffic control in order to safely protect the public

F. Computer and Internet connection
   1. Provide high speed broadband ISP.

G. Removal: Each installing Contractor shall remove his temporary utility, repair all damage caused in installation and restore to original conditions.

H. Cost of Installation, Operation and Maintenance
   1. Designated Contractor (below) will provide and maintain specified temporary utilities until Date of Substantial Completion unless otherwise indicated. Pay all costs of installation, operation and maintenance of temporary utilities.
      a. Temporary Heating: Geenral Contractor
      b. Temporary Ventilating: General Contractor
      c. Temporary Electricity: General Contractor

d. Temporary Lighting: General Contractor
e. Temporary Telephone: General Contractor
f. Temporary Water: General Contractor
g. Temporary Toilets: General Contractor
h. Temporary Enclosures: General Contractor

I. Cost of Consumables
1. Designated Contractor will pay all costs of consumables for temporary utilities unless otherwise indicated.
a. Temporary Heating
1) Heating Fuel: Each Contractor shall pay all costs of consumables for his own temporary heating requirements until the building is permanently enclosed.
b. Temporary Electricity
c. Electrical Energy: General Contractor.
d. Temporary Lighting
1) Lamps: General Contractor.
e. Temporary Water
1) Water: General Contractor.
f. Temporary Toilets
1) Toilet Supplies: General Contractor.

3.3 OTHER TEMPORARY FACILITIES

A. General: Contractor shall provide all other facilities necessary for the proper execution of the Project.

B. Water: Water used for pressure, leak and bacteria testing of the completed Plant tanks and lines is to be provided by the Contractor.

3.4 PAYMENT

A. Contractor's Cost: The Contractor shall pay for all temporary facilities.

B. Owner's Cost: None.

END OF SECTION 01 5000

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SECTION 01 5141

TEMPORARY PUMPING

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. This Section includes requirements for temporary pumping at facilities, such as treatment plants and pumping stations.
2. Contractor shall provide all labor, materials, tools, equipment, and incidentals shown, specified, and required for temporary pumping and handling of fluids during the Project.
3. Design, provide, and maintain temporary pumping systems, including plugs, bulkheads, and line stops as required; pumps; piping, supports, and valves; temporary instrumentation and control systems; fuel and electricity; personnel; and appurtenances. Comply with Laws and Regulations and requirements of authorities having jurisdiction. System shall be suitable for its service and operating environment.
4. Required capacity of temporary pumping systems is specified in Section 01 3113, Coordination. Provide temporary pumping system of required capacity with not less than the largest pump out of service.
5. Location of the temporary pumping system shall not affect Owner's or facility manager's operations and access at the Site, and public access to streets and drives, unless approved by Engineer and authorities having jurisdiction.

B. Coordination:
1. Review installation procedures under other Sections and coordinate Work that will be performed with or before Work specified in this Section.

C. Related Sections:
1. Section 01 3113, Coordination.
2. Section 01 3544, Spill Prevention Control and Countermeasures Plan.

1.2 QUALITYASSURANCE:

A. Qualifications:
1. Temporary Pumping System Supplier:
a. Supplier shall have not less than five years of experience providing temporary pumping systems similar in size or larger than those required for the Project.
b. Upon request, submit evidence of providing not less than five temporary pumping systems on other projects similar in size (or larger) and similar in service to temporary pumping systems required for the Project.

B. Component Supply and Compatibility:
1. Obtain each temporary pumping system from a single Supplier who shall be responsible for providing a complete system.

C. Regulatory Requirements:
1. Secondary containment for fuel tanks shall be in accordance with Laws and Regulations. Include temporary fuel tanks in spill prevention control and countermeasures evaluation and plan required in Section 01 3544, Spill Prevention Control and Countermeasures Plan.
2. Leakage from temporary pumping system or improper discharge is not allowed.

3. Quality of exhaust emissions from internal-combustion engines associated with temporary pumping systems shall comply with Laws and Regulations, including applicable air permits. Before furnishing temporary pumping system, verify compliance with air quality standards and provide temporary emissions controls to comply with such standards when required.

1.3 SUBMITTALS:

A. Timing: Furnish to Engineer submittals for temporary pumping system not less than 30 days prior to delivery of temporary pumping system to the Site.

B. Action Submittals: Submit the following:
   1. Temporary Pumping System Submittal: Submit the following for each temporary pumping system:
      a. System curve of flow plotted against total dynamic head, and calculations that substantiate the proposed temporary pumping system, including comparison of net positive suction head required and net positive suction head available.
      b. Manufacturer's data and specifications on each type and size of pump proposed and its capacity, including pump curves.
      c. Manufacturer's data and specifications for engines and other equipment required for temporary pumping system, including expected exhaust emissions data.
      d. Technical information and specifications on noise controls for noise-emitting equipment.
      d. Technical data on temporary piping, pipe joints, valves, pipe supports, controls, flow meter, secondary containment for fuel tanks, emissions controls when required, and other information pertinent to the temporary pumping system.
      e. Layout Drawings:
         1) Sketches showing proposed layout of temporary pumping system, including locations of temporary plugs, bulkheads, and line stops; suction and discharge locations; location of pumps and associated piping and valves; and source of power for temporary pumping system. Sketches shall be scale drawings acceptable to Engineer, and shall include site plans similar to those in the Contract Documents.
         2) Details of system suction and discharge locations. Discharge details shall include measures to protect the receiving structure and dissipate energy.
         3) Where temporary lines will be buried, submit trench details. Submit sketches and information on other types of protection proposed for temporary piping.
      f. Temporary Plugs, Bulkheads, and Line Stops: Manufacturer's literature and fabrication drawings showing type of plug, bulkhead or line stop as applicable, materials, and hydrostatic head the plug, bulkhead, or line stop is designed to withstand. Submit complete technical information for Contractor-proposed line stops, installation procedures, name of proposed line stop installer, and documentation of experience on at least five similar projects.
      g. Narrative describing proposed operation of temporary pumping system, including who will operate system, staffing, planned frequency of fueling, contingency plan in event of pump failure, and statement of existing systems that may be affected during operation of temporary pumping system.

C. Informational Submittals: Submit the following:
   1. Schedule for Temporary Pumping for Facilities:

a. Schedule for each temporary pumping system. Include dates of mobilizing each temporary pumping system, testing, starting and ending dates of temporary pumping, and demobilizing each temporary pumping system.
b. At Contractor's option, such information may be included on the Progress Schedule. When such option is exercised, however, upon request of Engineer break out as separate sub-schedule the schedule of temporary pumping in collection system and furnish to Engineer.
c. Maintain and update schedule for temporary pumping for collection system, and submit updated schedules in accordance with requirements for updating the Progress Schedule as indicated in Section 01 3300, Submittal Procedures.

2. Qualifications Statements:
a. Qualifications of temporary pumping system Supplier.

PART 2 – PRODUCTS

2.1 TEMPORARY PUMPING SYSTEM:

A. General:
1. System components shall be suitable for continuous operation with the fluid pumped.
2. Noise Controls: Provide noise controls for temporary pumping system. Noise emitted from temporary pumping system shall comply with Laws and Regulations and shall not exceed 70 db at a distance of thirty feet from noise source.
3. Fuel-consuming temporary pumping system components intended for use when Contractor is not present shall include fuel tanks sized for not less than 24 hours of uninterrupted operation at system's operating capacity, and means to automatically notify Contractor upon high and low suction water level and low fuel level.

B. Instrumentation and Controls:
1. Controls: Provide controls for temporary pumping system in accordance with Section 01 3113, Coordination.

C. Temporary Piping System:
1. Piping shall be steel, ductile iron, high density polyethylene, or other material accepted by Engineer, and suitable for system operating pressures. Aluminum piping and PVC piping not mechanically restrained are not allowed. Durable hoses can be used only for short sections and with acceptance by Engineer.
2. Piping system shall have watertight joints of the following types: fused joints, restrained couplings, flanged coupling adapters, quick-connects by Camlok or equal, flanged joints, grooved and shouldered end-type couplings, and other watertight joints accepted by Engineer.
3. Size discharge piping for flow velocity of not more than 10 feet per second.
4. Provide check valves or approved pump control valves as required.
5. Provide air valves on discharge piping as required. Air valves shall expel air upon pipe filling and admit air upon pipe dewatering, and release small quantities of entrained air during operation. Air valves shall be suitable for service with the pumped fluid.
6. Discharge from temporary pumping system shall not adversely affect the existing process or facilities. Provide energy-dissipating measures at discharge point as necessary.

D. Temporary Plugs, Bulkheads, and Line Stops:
1. Acceptable temporary plugs and bulkheads include inflatable dams specifically designed for such service, brick bulkheads, timber bulkheads, sandbags, and other bulkhead methods

suitable for the service and conduit conditions. Line stops, where required, are specified in Division 40 of the Contract Documents.

2. Each plug, temporary bulkhead, and line stop shall be suitable for the maximum pressure encountered.
3. Where temporary plugs and bulkheads are under pressure or surcharged, provide either two plugs or a plug and temporary bulkhead.

PART 3 – EXECUTION

3.1 PREPARATION:

A. General:
1. Temporary piping shall be located off of roads, driveways, and sidewalks. Piping shall not be located in environmentally-sensitive areas such as wetlands.
2. Where required for Owner's access to and operation of existing facilities, bury temporary piping that would otherwise inhibit access to processes, buildings, structures, streets, and driveways. In paved areas, provide temporary surfacing, sufficient for AASHTO H-20 wheel loads over buried temporary piping.
3. Hydrostatic Testing of Temporary Piping System:
   a. Perform successful hydrostatic testing of temporary piping system using clean water at pressure equal to 1.2 times highest expected system operating pressure, for one hour while maintaining test pressure within 3.0 psig of required test pressure.
   b. Engineer will witness hydrostatic test.
   c. Hydrostatic test criteria for acceptance: No leakage.
4. Verify that entire temporary pumping system is ready for operation before commencing shutdown of Owner's operations, facility, or systems. Verify that temporary pumping system controls and flow meter are properly connected and functional.

3.2 TEMPORARY PUMPING:

A. During Operation of the Temporary Pumping System:
1. Temporary pumping system shall operate continuously. In the event of equipment failure, immediately make repairs or replace equipment. Provide spare parts and redundant units as necessary for continuous operation.
2. Provide personnel to monitor, operate, and maintain temporary pumping system twenty-four hours per day when system is in service.

3.3 DEMOBILIZATION:

A. Upon Conclusion of Temporary Pumping:
1. Remove plugs, bulkheads, and line stops in manner that allows flow to slowly return to normal, without surging, surcharging, and adverse effects on existing system.
2. Flush out temporary pumping system with clean water discharged to an appropriate location.
3. Remove temporary pumping system and appurtenances from the Site.
4. When Contractor has obtained permit(s) for temporary pumping from authorities having jurisdiction, furnish written notice to such authorities that temporary pumping has been completed.

END OF SECTION 01 5141

SECTION 01 5705

TEMPORARY CONTROLS

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide and maintain methods, equipment, and temporary construction as required to control environmental conditions at the Site and adjacent areas.
2. Maintain controls until no longer required.
3. Temporary controls include, but are not limited to, the following:
a. Erosion and sediment controls.
b. Noise controls.
c. Dust control.
d. Pest and rodent control.
e. Control of water, including storm water runnoff.
f. Pollution control.

B. Related Sections:
1. Section 01 3544, Spill Prevention Control and Countermeasures Plan.
2. Section 01 4126, Stormwater Pollution Prevention Plan and Permit.
3. Section 01 3543.13, Environmental Procedures for Hazardous Materials.
4. Section 31 2305, Excavation and Fill.

1.2 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with applicable provisions and recommendations of the authorities having jurisdiction.

1.3 SUBMITTALS:

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Plan for construction staging and maintenance of the Site relative to erosion and sediment controls. Indicate on a Site plan approximate areas of planned disturbance of soils and soil cove over time during the Project. For areas not indicated in the Contract Documents as being disturbed and that Contractor proposes to disturb, Shop Drawing shall include proposed erosion and sediment control measures for the additional area.
b. Location and details of temporary settlement basin(s).
2. Product Data:
a. Silt fencing materials.

B. Informational Submittals: Submit the following:
1. Procedural Submittals:
a. Proposed dust control measures, when submittal is requested by Engineer.

PART 2 – PRODUCTS

2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS:

A. Materials for temporary erosion and sediment controls shall be as shown or indicated on the Drawings.

B. Silt Fencing:
   1. Filter Cloth:
      a. Mirafi Envirofence, or equal.
      b. Height: Two feet, minimum.
      c. Securely fasten filter cloth to wire mesh using ties spaced at maximum intervals of two feet on centers at top and mid-height of wire mesh.
   2. Wire Mesh: Support filter cloth with wire mesh complying with the following:
      a. Woven wire mesh, 14-gauge steel wire, maximum mesh size six-inch by six-inch.
      b. Height: To match filter cloth height.
      c. Fasten wire mesh to fence supports with wire ties or staples.
   3. Fence Support Posts:
      a. Length: Three feet, minimum.
      b. Material: Metal or other acceptable material with "U" or "I" cross section, or minimum 1.25-inch by 1.25-inch hardwood.

C. Straw Bale Dike.
   1. Bales shall be firmly-packed, unrotted straw bound firmly with baling wire. Cross-sectional area on the small end of each bale shall be approximately 12 inches by 12 inches or larger.
   2. Posts shall comply with requirements for silt fencing support posts, or may be suitable reinforcing steel.

D. Mulch Materials and Soil Stabilization.
   1. Mulch shall be unrotted straw or salt hay.
   2. Soil stabilization emulsions, when used, shall be an inert, eco-friendly chemical manufactured for the specific purpose of erosion control and soil stabilization, applied with mulch or stabilization fibers.
   3. Wood-fiber or paper-fiber, when used, shall be 100 percent natural and biodegradable.
   4. Erosion control mat or netting shall be biodegradable. Acceptable materials include jute, excelsior, straw or coconut fiber, and cotton.

E. Protection of Storm Water Drainage Inlets and Catch Basins:
   1. Inlet Filter Bag:
      a. Product and Manufacturer: Provide one of the following for each drainage inlet or catch basin to be protected:
         1) Silt Sack, by Atlantic Construction Fabrics (ACF) Environmental
         2) Or equal.
      b. Inlet filter bag permeability shall be not less than 40 gallons per square foot of bag area exposed to the flow. Fabric shall be woven polypropylene with double stitching to prevent bursting.
      c. Inlet filter bags shall fit inside the drainage inlet or catch basin and shall be secured by the structure's grate or by other acceptable means.

d. Inlet filter bags shall have means of removing inlet filter bag and the silt and sediment collected in the bag, without dumping filter bag's contents into the drainage inlet or catch basin.

F. Temporary Settlement Basin.
1. Embankment Material: Comply with requirements for general fill in Division 31 Sections on earthwork, excavation, and fill.
2. Provide outfall structure consisting of overflow weir and discharge pipe, and provide emergency spillway.
3. Overflow Weir and Discharge Pipe: Suitably-sized piping of corrugated metal, high-density polyethylene, or other suitable material. Pipe may be new or used; if used, pipe shall be in good condition.

G. Filter Bag on Dewatering Pump Discharge:
1. Provide filter bag on discharge of each dewatering pump drawing from an excavation. Filter bag is not required on pumps associated with dewatering wells.
2. Products and Manufacturers: Provide one of the following:
a. UltraTech Dewatering Bag, by Interstate Products.
b. Filter Bag, by US Fabrics.
c. Dewatering (Filter) Bag, Indian Valley Industries.
d. DirtBag, by Atlantic Construction Fabrics (ACF) Environmental
e. Or equal.
3. Size filter bags for maximum flow of the pump. Filter bags shall be specifically fabricated for use as a dewatering pump filter bag.
4. Provide sufficient spare filter bags for continuous dewatering operations.

H. Temporary Stone Construction Entrance:
1. Stone: Tough, hard, durable stone complying with the following gradation requirements:

Sieve Size	Total Percent Passing
Four-inch (100 mm)	100
3.5-inch (90 mm)	90 to 100
2.5-inch (65 mm)	25 to 60
1.5-inch (37.5 mm)	Zero to 15

2. Geotextile: As recommended by geotextile manufacturer for separating stone from subgrade, for the vehicle weight and traffic frequency required.

PART 3 – EXECUTION

3.1 NOISE CONTROL:

A. Noise Control – General:
1. Contractor’s vehicles and equipment shall minimize noise emissions to greatest degree practicable. Provide mufflers, silencers, and sound barriers when necessary.
2. Noise levels shall comply with Laws and Regulations, including OSHA requirements and local ordinances.
3. Noise emissions shall not interfere with the work of Owner or others.

3.2 DUST CONTROL:

A. Dust Control – General:
1. Control objectionable dust caused by Contractor's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of Engineer and approval of authorities having jurisdiction.
2. Contractor shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on- and off-Site damage, nuisances, and health hazards associated with dust emissions. Control may be achieved by irrigation in which the Site shall be sprinkled with water until the surface is moist. Apply dust controls as frequently as required without creating nuisances such as excessive mud and ponding of water at the Site.
3. Remove dust from roadways and access roads at maximum intervals of seven days by mechanical brooming or other method acceptable to Engineer.

B. Comply with Section 01 4127, Earthmoving Permit and Dust Control.

3.3 PEST AND RODENT CONTROL:

A. Pest and Rodent Control – General:
1. Provide rodent and pest control as required to prevent infestation of the Site and storage areas.
2. Employ methods and use materials that do not adversely affect conditions at the Site or on adjoining properties.
3. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled.

3.4 WATER CONTROL:

A. Water Control – General:
1. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, and adjoining properties.
2. Control fill, grading, and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses to prevent erosion, damage, or nuisance.

B. Equipment and Facilities for Water Control: Provide, operate, and maintain equipment and facilities of adequate size to control surface water.

C. Discharge and Disposal: Dispose of drainage water in manner to prevent flooding, erosion, and other damage to any and all parts of the Site and adjoining areas, and that complies with Laws and Regulations.

3.5 POLLUTION CONTROL:

A. Pollution Control – General:
1. Provide means, methods, and facilities required to prevent contamination of soil, water, and atmosphere caused by discharge of noxious substances from construction operations.
2. Equipment used during construction shall comply with Laws and Regulations.
3. Refer to Section 01 3543.13, Environmental Procedures for Hazardous Materials.

B. Spills and Contamination:

1. Provide equipment and personnel to perform emergency measures required to contain spills and to remove contaminated soils and liquids.
2. Excavate contaminated material and properly dispose of off-Site, and replace with suitable compacted fill and topsoil.
3. Refer to Section 01 3544, Spill Prevention Control and Countermeasures Plan

C. Protection of Surface Waters: Implement special measures to prevent harmful substances from entering surface waters. Prevent disposal of wastes, effluents, chemicals, and other such substances in or adjacent to surface waters and open drainage routes, in sanitary sewers, or in storm sewers.

D. Atmospheric Pollutants:
1. Provide systems for controlling atmospheric pollutants related to the Work.
2. Prevent toxic concentrations of chemicals and vapors.
3. Prevent harmful dispersal of pollutants into atmosphere.

E. Solid Waste:
1. Provide systems for controlling and managing solid waste related to the Work.
2. Prevent solid waste from becoming airborne, and from discharging to surface waters and drainage routes.
3. Properly handle and dispose of solid waste.

3.6 EROSION AND SEDIMENT CONTROL:

A. Installation and Maintenance of Erosion and Sediment Controls – General:
1. General:
   a. Provide erosion and sediment controls as shown and indicated on the Drawings and elsewhere in the Contract Documents. Provide erosion and sediment controls as the Work progresses into previously undisturbed areas.
   b. Installation of erosion and sediment controls shall be in accordance with the applicable regulatory requirements indicated in Article 1.2 of this Section, unless otherwise shown or indicated in the Contract Documents.
   c. Use necessary methods to successfully control erosion and sedimentation, including ecology-oriented construction practices, vegetative measures, and mechanical controls. Use best management practices (BMP) in accordance with Laws and Regulations, and regulatory requirements indicated in Article 1.2 of this Section, to control erosion and sedimentation during the Project.
   d. Plan and execute construction, disturbances of soils and soil cover, and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation. Provide temporary measures for controlling erosion and sedimentation, as indicated in the Contract Documents and as required for the Project.
   e. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provisions shall be made for regulating drainage and controlling erosion and sedimentation, subject to the Engineer's approval.
   f. Provide erosion and sediment controls, including stabilization of soils, at the end of each workday.
2. Coordination:
   a. Coordinate erosion and sediment controls with this Section's requirements on water control and with Section 01 4126, Stormwater Pollution Prevention Plan and Permit.

b. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities and other Work to the extent necessary for economical, effective, and continuous erosion and sediment control.

3. Before commencing activities that will disturb soil or soil cover at the Site, provide all erosion and sediment control measures required by the Contract Documents for the areas where soil or soil cover will be disturbed.
4. In general, implement construction procedures associated with, or that may affect, erosion and sediment control to ensure minimum damage to the environment during construction. Contractor shall implement any and all additional measures required to comply with Laws and Regulations, and Section 01 4126, Stormwater Pollution Prevention Plan and Permit.
5. Vegetation Removal: Remove only those shrubs, grasses, and other vegetation that must be removed for construction. Protect remaining vegetation.
6. Access Roads and Parking Areas: When possible, access roads and temporary roads shall be located and constructed to avoid adverse effects on the environment. Provisions shall be made to regulate drainage, avoid erosion and sedimentation, and minimize damage to vegetation.
7. Earthwork and Temporary Controls:
   a. Perform excavation, fill, and related operations in accordance with Section 31 2305, Excavation and Fill.
   b. Control erosion to minimize transport of silt from the Site into existing waterways and surface waters. Such measures shall include, but are not limited to, using berms, silt fencing, baled straw silt barriers, gravel or crushed stone, mulching and soil stabilization, slope drains, and other methods. Apply such temporary measures to erodible materials exposed by activities associated with the construction of the Project.
   c. Hold to a minimum the areas of bare soil exposed at one time.
   d. Construct fills and waste areas by selectively placing fill and waste materials to eliminate surface silts and clays that will erode.
   e. In performing earthwork, eliminate depressions that could serve as mosquito pools.
   f. Contractor shall provide special care in areas with steep slopes, where disturbance of vegetation shall be minimized to maintain soil stability.
8. Inspection and Maintenance:
   a. Periodically inspect areas of earthwork and areas where soil or soil cover are disturbed to detect evidence of the start of erosion and sedimentation; apply corrective measures as required to control erosion and sedimentation. Continue inspections and corrective measures until soils are permanently stabilized and permanent vegetation has been established
   b. Inspect not less often than the frequency specified in Section 01 4126, Stormwater Pollution Prevention Plan and Permit.
   c. Repair or replace damaged erosion and sediment controls within 24 hours of Contractor becoming aware of such damage.
   d. Periodically remove silt and sediment that has accumulated in or behind sediment and erosion controls. Properly dispose of silt and sediment.
9. Duration of Erosion and Sediment Controls:
   a. Maintain erosion and sediment controls in effective working condition until the associated drainage area has been permanently stabilized.
   b. Maintain erosion and sediment controls until the Site is restored and site improvements including landscaping, if any, are complete with underlying soils permanently stabilized.

10. Work Stoppage: If the Work is temporarily stopped or suspended for any reason, Contractor shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.
11. Failure to Provide Adequate Controls: In the event Contractor repeatedly fails to satisfactorily control erosion and siltation, Owner reserves the right to employ outside assistance or to use Owner's own forces for erosion and sediment control. Cost of such work, plus engineering and inspection costs, will be deducted from monies due Contractor.

B. Silt Fencing:
1. Install and maintain silt fencing in a vertical plane, at the location(s) shown or indicated on the Drawings.
2. Locations of Silt Fencing:
   a. Where possible, install silt fencing along contour lines so that each given run fencing is at the same elevation.
   b. On slopes install silt fencing at intervals that do not exceed the maximum intervals indicated in the following table:

Slope (percent)	Maximum Length of Slope Above Each Silt Fence (feet)
2 and less	150
2.1 to 5	100
5.1 to 10	50
10.1 to 20	25
20.1 to 25	20
25.1 to 40	15
40.1 to 50	10

   c. Provide silt fencing around perimeter of each stockpile of topsoil, general fill material, and excavated material. Install silt fencing before expected precipitation and maintain until stockpile is removed.
   d. Do not install silt fencing at the following types of locations:
      1) Area of concentrated storm water flows such as ditches, swales, or channels.
      2) Where rock or rocky soils prevent full and uniform anchoring of silt fencing.
      3) Across upstream or discharge ends of storm water piping or culverts.
3. Installation:
   a. Securely fasten wire mesh to posts, and securely fasten filter cloth to wire mesh.
   b. When two sections of filter cloth abut each other, fold over edges and overlap by minimum of six inches and securely fasten to wire mesh.
   c. Embed posts in the ground to the depth necessary for proper controls; embed posts to at least 16 inches below ground.
   d. Filter cloth and wire mesh shall extend a minimum of eight inches below ground and a minimum of 16 inches above ground.
   e. Remove sediment accumulated at silt fencing as required. Repair and reinstall silt fencing as required.
4. Maintenance:
   a. Do not allow formation of concentrated storm water flows on slopes above silt fencing unless so shown or indicated in the Contract Documents. If unauthorized concentrated storm water flows occur, stabilize the slope via earthmoving and other stabilization measures as required to prevent flow of concentrated storm water flows toward silt fencing.

C. Straw Bale Dike.
   1. Install straw bale dikes where shown or indicated, including in swales, along contours, and along toe of slopes.
   2. Install bales in shallow excavation as wide as the bale and approximately four to six inches below surrounding grade.
   3. Ends of bale shall tightly abut ends of adjacent bales.
   4. Securely install straw bales using two support posts per bale, driven into the ground a minimum of 1.5 to two feet below bottom of bale. Top of post shall be flush with top of bale. Angle first post for each bale toward the previously-installed bale.
   5. Frequently inspect bales and repair or replace as required. Remove accumulated silt and debris from behind straw bales.

D. Mulching and Soil Stabilization:
   1. Use mulching to temporarily stabilize exposed soil and fill material.
      a. Immediately following final grading, provide mulch and stabilize with mats or netting, or sprayed soil stabilization emulsion with fiber additive.
      b. Application of mulching for soil stabilization shall be as follows.
         1) Unrotted Straw or Salt Hay: 1.5 to two tons per acre.
         2) Soil stabilization emulsions, when used, shall be applied in accordance with manufacturer's instructions, and shall be applied with mulch or stabilization fibers.
         3) Wood-fiber or Paper-fiber Application: 1,500 lbs. per acre, installed by hydroseeding.
      c. Where mats or netting are used:
         1) Cover entire area to be stabilized with mats or netting.
         2) Provide anchoring trenches at the top and bottom of slopes to receive mats or netting. Bury at least the top and bottom ends of mat or netting, four inches or more wide, at top and bottom of slope. Tamp trench full of soil. Four inches from trench, secure mat or netting with appropriate staples spaced at intervals of 10 inches.
         3) Overlap adjacent strips of mat or netting by at least four inches.

E. Protection of Storm Water Drainage Inlets and Catch Basins:
   1. Protect each drainage inlet and catch basin that has the potential to receive storm water runoff from exposed soils, and does not discharge into a storm water settlement basin.
   2. Install inlet filter bags inside of drainage inlet or catch basin in accordance with manufacturer's instructions. Secure inlet filter bag with the structure's grate or by other acceptable means.
   3. Inlet filter bags shall not pose any obstruction above the elevation of the drainage inlet or catch basin grate requiring barricades or flashers.
   4. When removing silt and sediment from inlet filter bag, do not dumpi filter bag's contents into the drainage inlet or catch basin.
   5. Remove silt and sediment from inlet filter bag, or replace inlet filter bag, when inlet filter bag is not more than half full.

F. Temporary Settlement Basin.
   1. For constructing embankments comply with requirements in Division 31 Sections on earthwork, embankments, excavation, and fill.
   2. Overflow Weir and Discharge Pipe:
      a. Install piping in accordance with manufacturer's instructions.

b. Install overflow weirs at elevations on shown or indicated on the Drawings or approved Shop Drawings, as applicable, to avoid overtopping and overfilling of settlement basin without short-circuiting the settlement basin's hydraulics.
c. Wrap geotextile material specified for silt fencing around discharge structures of temporary settlement basins

3. Crushed Stone and Riprap: Install in accordance with Division 31 Sections on crushed stone and riprap. Provide in areas of temporary settlement basin subject to erosion, and at upstream and downstream ends of discharge piping.
4. Remove sediment when required based on accumulation of material.
5. When temporary settlement basin is no longer required, remove the temporary settlement basin discharge weir , discharge pipe, and spillway, fill the temporary sediment basin to required grade in accordance with requirements of Division 31 Section on excavation and fill, and provide landscaping in accordance with Division 32 Sections on landscaping.

G. Filter Bag on Dewatering Pump Discharge:
1. Provide dewatering of excavations in compliance with Division 31 Sections on earthmoving, excavation, and fill.
2. Locate filter bags and temporary pump discharge lines to avoid interfering with the public, use of private property, and Owner's operations. Relocate filter bags and appurtenances when required.
3. Filter bag discharge shall be directed to appropriate storm water drainage route. Do not discharge into roadways, driveways, access roads, and overland. When temporary settlement basin is used, locate filter bags to discharge to temporary settlement basin when practicable.
4. Provide filter bag on discharge of each dewatering pump drawing from an excavation.
5. Securely attach filter bag to pump discharge pipe or hose.
6. Maintain, clean out, and replace filter bags as required.

H. Temporary Stone Construction Entrance:
1. Where shown on the Drawings, and where construction vehicles will regularly transit to paved surfaces from unstabilized surfaces, provide a temporary stone construction entrance. Contractor vehicles shall use temporary construction entrances.
2. Provide temporary stone construction entrances of the width, length, and thickness shown or indicated on the Drawings. When not shown or indicated on the Drawings, temporary stone construction entrance shall be not less than 50 feet long, by 20 feet wide, by eight inches deep.
3. Installation:
a. Ensure that subgrade under temporary stone construction entrance is suitably dense for the intended purpose. Suitably prepare subgrade as required for temporary construction entrance.
b. Provide on subgrade a layer of geotextile fabric, installed in accordance with geotextile manufacturer's recommendations for separation.
c. Provide stone on installed geotextile. Grade stone for passage of vehicles.
4. Maintenance:
a. Maintain temporary stone construction entrance at not less than the minimum required thickness. Add stone as required to maintain thickness.
b. When upper layer of temporary stone construction entrance becomes contaminated with soil, remove the contaminated material and replace with clean stone.
c. Using water to wash down temporary construction entrance or paved areas onto which soil material has been tracked is not allowed.

3.7 REMOVAL OF TEMPORARY CONTROLS:

A. Removals – General:
   1. Upon completion of the Work, remove temporary controls and restore Site to specified condition; if condition is not specified, restore Site to pre-construction condition.
   2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

END OF SECTION 01 5705

SECTION 01 6000

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 FABRICATION

A. Fabricate all items in the shop insofar as possible. Where items cannot be completely shop-fabricated and assembled for shipment, assemble and fit in shop, disassemble and ship. Identify parts for field assembly. Fabricate items to be straight, square, in proper alignment, and with hairline joints where joints are necessary. Pre-plan field joints to be as inconspicuous as possible.

1.3 SHOP PRIMING

A. Shop prime or seal surfaces of all products to receive paint materials in accordance with requirements of the Contract Documents. Apply a primer or sealer compatible with the specified paint materials. If such primer is determined to be incompatible with the specified paint materials, provide a barrier coat or remove the primer and prime again as required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Packing: Deliver products in properly identified original packages or other containers with unbroken seals and manufacturer's labels, grade marks and other means of identification in place.

B. Shipping/Delivery
   1. Protect products during shipment to maintain the product's original characteristics.
   2. Deliver materials and equipment which will require controlled storage conditions on Site after the controlled storage provisions have been made on Site.
   3. Deliver materials, supplies, or equipment to Project site during working hours.
   4. Deliveries made during other than normal working hours must be received by an authorized agent of Contractor involved or be received by other means which shall be the sole responsibility of that Contractor.
   5. No employee of the Owner or Engineer is authorized to receive any shipment designated for this Project.
   6. The Owner or Engineer assumes no responsibility for receiving any shipment designated for this Project.
   7. Any materials delivered in the presence of Owner's or Engineer's representative shall be accounted for by the respective Contractor.
   8. Under no circumstances may shipments be directed to, or in care of, the Owner.
   9. Each Contractor, Subcontractor, manufacturer, or supplier furnishing materials to the site shall identify, ship, address, consign, etc. all such materials to the Contractor who may be charged therewith by giving the name of the Contractor, the name and address of the Project.

C. Unloading and Acceptance
   1. Deliver products in properly identified original packages or other containers with unbroken seals and manufacturer's labels, grade marks and other means of identification in place.
   2. Check each item for completeness of order, physical condition and conformance to the Contract Documents. Reject products which do not conform to these requirements, or which have been damaged beyond repair or restoration to original condition as approved by Engineer.

D. Protection
   1. Protect products during shipment and on Site to maintain the original product characteristics.
   2. Protect all finished surfaces from damage during installation. Provide protective devices as required and as recommended by the manufacturer. Cover work subject to damage at the end of each day's work.
   3. Coat concealed surfaces of metal products with a bituminous or other approved coating to prevent contact between dissimilar metals or other material which can cause deterioration.
   4. Correct damage by repairing or replacing as required by Engineer. Repairing will be permitted only where the repair is undetectable and does not cause structural damage or interfere with proper functioning of the part.
   5. Protect finish of installed products until Substantial Completion of the Project by use of wrappings, covers, or other approved protective devices. Remove such protection immediately prior to final cleaning.

E. On-Site Storage
   1. Store hazardous products, such as paint materials, in well ventilated areas in accordance with applicable standards and governing laws.
   2. Store materials off the ground and in a manner to prevent damage or intrusion of moisture or other foreign matter.
   3. Cover materials which may be damaged by weather, allowing for proper circulation of air.
   4. When possible, store materials inside the building or in sheds.
   5. When storing materials in the building, stockpile materials in a manner which will not overload the structure.
   6. Store all materials in a manner immediately accessible for inspection.
   7. Store small items, such as finish hardware and other items easily stolen or vandalized, in a security area. Where possible, do not deliver such items until immediately prior to installation.

1.5 INSTALLATION STANDARDS

A. Examination of Substrate: Examine the substrate or structure to which a product is to be applied or installed. Check the substrate or structure for proper clearances and tolerances. Tolerances are listed in each Section. Do not proceed until unsatisfactory conditions have been corrected. Starting the work indicates acceptance of conditions and the installer assumes full responsibility for results.

B. Preparation
   1. Substrate: Where products are applied to a substrate, prepare the substrate as recommended by the product manufacturer, generally as follows:

a. Bring substrate to a uniform surface by smoothing uneven surfaces and filling holes, cracks and low places with recommended filler or parent material.
b. Remove substances, such as dust, oils and other foreign matter, not compatible with the product.
c. Surfaces shall be dry, unless a moisture content or wetting is specified.

2. Inserts and Anchorages
   a. Installer shall furnish built-in fastening devices for his product to the proper trade for installation as the work proceeds.
   b. If such devices are not furnished in time to be built in, installer shall provide alternate methods for attaching his product. Submit Drawings and other required data as Reference Submittals.
3. Templates: Provide templates, diagrams and other coordinating documents to the proper Contractor, manufacturer, or supplier of related items affecting the work.
4. Dimensions
   a. If the exact location of an item is not indicated by dimension on the Drawings or noted in the Specifications, Engineer reserves the right to determine such location in the field prior to roughing in.
   b. If the exact dimensions of a product are not indicated, Engineer reserves the right to determine dimensions prior to ordering or fabricating the product.
   c. Such dimensional changes shall not be a basis for changes in the Contract Sum.
   d. Where miscellaneous devices, such as thermostats, switches, controls, grilles, pipes, or outlets of any nature are not exactly located by the Contract Documents, request such location or obtain approval of the location prior to installation. If approval has not been obtained, Engineer may require the relocation of such devices at the expense of the installer.

C. Installation
1. Install products in accordance with the manufacturer's recommendations or the requirements of trade associations, listed standards, conforming Shop Drawings, and Contract Documents. Where a conflict exists between these references, the most strict requirements govern. If printed instructions are not available, consult with the manufacturer's field representative.
2. Provide hangers, auxiliary framing, and other means for installing ceiling suspension systems, lighting fixtures, diffusers, and other equipment in ceilings to avoid ducts, piping, etc.
   a. Suspend from structural members, such as joists or beams, and not from ducts or piping.
3. Install work in a manner which will not interfere with the proper installation of the work of other trades and to facilitate operating, servicing, and repairing.
4. Install products straight, plumb, level, and in line. Securely attach items to the substrate, using recommended adhesives, mechanical fasteners or other devices. Where holes are provided for attachment, do not field drill or cut new holes without approval of Engineer.
5. Match all finished work to the submitted Samples or Sample panels.
6. Conceal fasteners wherever possible, unless exposed fasteners are permitted or specified.
7. Weld in accordance with AWS standards for qualifications of operators and for workmanship.

1.6 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to Instructions to Bidders for requirements and approval process of substitute materials, products, and systems.

B. Manufacturers, Products, Materials, Equipment and Systems

1. General: Where more than one manufacturer, product, material, equipment item, or system is indicated as acceptable, provide any one named. No substitutions will be permitted after signing the Contract.
2. Contractor's Option
   a. In many instances this Project has been designed around a specific manufacturer with other manufacturers listed as acceptable.
      1) Products from such other listed manufacturers will be accepted contingent upon meeting the design, appearance and functional standards established by the specified items.
   b. If any changes to the Contract Documents or work are required to accommodate an acceptable product of one such other listed manufacturer, the Contractor whose product requires such changes shall pay all additional costs involved with no additional cost to the Owner or Engineer. Such additional costs to be paid by such Contractor shall include, but not be limited to, all additional costs required for changes in the work of such Contractor and of all other Contractors as well as all costs for additional services of the Reviewer to review such changes.
   c. Payments for such additional services of the Reviewer shall be made as follows:
      1) Owner will compensate Engineer.
      2) Owner will deduct the amount of such compensation from payments to the Contractor.
3. Unavailability of Product: When all of the products listed in the Contract Documents for a specified item are no longer being manufactured, or when products are not listed and all of the conforming products of manufacturers listed in the Contract Documents for a specified item are no longer being manufactured, then submit, through the Change Order process, the name of another product and manufacturer for review and approval by the Reviewer. Submit all documentation required elsewhere in the Contract Documents and as required by the Reviewer to show proof that the submittal is an equal in every respect to the item specified.
4. Performance Specification: Where a performance is specified and no manufacturer is listed, submit through the Shop Drawing procedure the name of the manufacturer, the product proposed, and detailed information showing its characteristics.
5. Color, Pattern, Texture: Where a choice of color, pattern, or texture is available for a specified product or item of equipment, the Reviewer will make a selection from the manufacturer's highest or best standards, unless noted otherwise in the technical sections of the Project Manual.

END OF SECTION 01 6000

SECTION 01 7500

STARTING AND ADJUSTING

PART 1 GENERAL

1.1 REFERENCE

A. The requirements of Division 01 apply to the work of all other sections.

1.2 SCOPE

A. Section includes initial testing and balancing of all process and electrical systems.

1.3 TESTING, ADJUSTING AND BALANCING SYSTEMS

A. Testing
   1. Contractor shall establish an orderly procedure for testing the project and portions of the project.
   2. Contractor shall test each individual system prior to final acceptance.
   3. Prior to starting any testing, Contractor shall submit, in writing, to the Owner and Engineer a tentative schedule of tests and a description of the test to be conducted on each system for approval.
   4. Engineer and/or Owner may observe any and all testing.
   5. Contractor shall be responsible for operation and maintenance of all systems until accepted by the Owner, at which time the Owner assumes responsibility for operation and maintenance.
   6. Test all systems or structures after they are complete, ready for operation, and the necessary arrangements have been made to provide testing media.
      a. Contractor shall provide all test media, unless otherwise indicated.
      b. Test with water all liquid systems, including liquid chemicals.
   7. Tests shall verify that all components of the system operate properly through the full design ranges.
   8. Test completion shall not, by itself, constitute acceptance of the system or any part of the system.
   9. Contractor shall provide all materials necessary to conduct tests, unless otherwise indicated.

B. Adjusting
   1. Contractor shall be responsible for making necessary adjustments and repairs to items he has installed.
   2. When testing indicates deficiencies in any portion of the work, Contractor shall make necessary adjustments and repairs immediately. Repeat the test until all deficiencies are corrected.

1.4 SYSTEMS DEMONSTRATIONS

A. Where required, instruct Owner's personnel in operating procedures, maintenance, safety precautions, and use of manuals and other literature.

END OF SECTION 01 7500

SECTION 01 7700

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 FINAL CLEANING

A. At completion of the work, prior to the Owner's occupancy and prior to submittal of Application for Final Payment, perform final cleaning.

B. Perform the following general cleaning:
   1. Remove from the Site all temporary facilities, fences, scaffolding, tools and equipment, and surplus materials.
   2. Remove all rubbish, loose plaster, mortar drippings, extraneous construction materials, dirt and dust from electrical closets, pipe and duct shafts, chases, furred spaces, and similar unfinished spaces.
   3. Remove all temporary protective devices.
   4. Repair, patch and touch-up damaged surfaces to specified finish to match adjacent surfaces. Replace damaged materials which cannot be satisfactorily repaired.
   5. Broom clean paved surfaces and rake clean other surfaces of the Site.

C. Perform the following cleaning and polishing:
   1. Clean all interior and exterior surfaces exposed to view:
      a. Remove paint spatters, stains, dirt, grease, finger smudges and other marks, soiling, and foreign matter.
      b. Remove all labels.
      c. Remove all dust and dirt by vacuuming and washing.
   2. Each Contractor shall do all cleaning of finish surfaces relative to its work prior to acceptance of their work. General Contractor shall do a subsequent final cleaning including, but not limited to all glass; remove stains, spots, marks, and dirt from decorated work and finished surfaces; clean all hardware; wash all concrete, ceramic tile finishes and clean all flooring materials in accordance with Specifications prior to final acceptance by the Owner. Each Contractor shall comply with all special cleaning instructions, contained in the Specifications.
   3. Clean and polish finished surfaces in accordance with the manufacturer's instructions or with the special cleaning instructions in the technical sections.
   4. Clean visible portions of mechanical and electrical equipment and fixtures. Clean inside lighting fixtures and lenses.

D. Perform and maintain specified cleaning of Project until the Owner's occupancy. Recleaning will not be required after the Owner's occupancy unless later operations of the Contractor make recleaning necessary.

1.3 PROJECT RECORD DOCUMENTS

A. As-Built Drawings

1. Maintain at the Site, for the Owner, one copy of all Drawings, Specifications, approved copies of Building Department Documents, Addenda, Change Orders, Modifications, Shop Drawings, Product Data and Samples in good order and marked currently to record all changes made during construction. These As-Built Drawings shall be available to Engineer.
2. Deliver to Engineer for the Owner's file, at the completion of the work, an accurate set of marked-up as-built documents, including a copy of the Project Manual and the Drawings, showing the Project, insofar as the actual construction or installation differs from the Documents. Final payment will not be made until receipt of complete As-Built documents.
    a. Engineer will provide one set of Drawings and Project Manual to be specifically used for this purpose.
3. Include Drawings for all Site, General, Plumbing, Heating, Ventilating and Air Conditioning, and Electrical Trades. Record all changes and information such as:
    a. Elevation at bottom of foundations in relation to finished first floor
    b. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements
    c. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure
    d. Changes of dimensions plan arrangement, material, and details
    e. Changes made by Field Order or by Change Order
    f. Details not on original Contract Drawings
4. Note in each Specification Section the actual manufacturer's trade name, catalog number and supplier of each product incorporated into the work. Note changes made by Change Order.
5. Maintain all such documents at the Site during each step of the work.
6. While RFI’s and RFP’s can be taped to the back of the previous Drawing, the revised work must still be marked legibly on the Drawing.
7. Electronic copy of final site plan as prepared by professional surveyor shall be submitted to Engineer. All elevations of structures at catch basins and manholes, and invert elevations shall be noted. As-built elevation point files shall be provided.

1.4 WARRANTIES AND BONDS

A. Special Guaranties and Warranties

1. General
    a. Special guaranties and warranties are in addition to all other guaranties and warranties required elsewhere in the Contract Documents.
    b. Definitions
        1) A Guaranty is a separate Contract by a third party, covering responsibility if a principal fails to perform.
        2) A Warranty is a principal's own assurance that he will assume stipulated responsibilities.
    c. Submit certificates of these guaranties and warranties, properly dated and executed. Such warranty shall not preclude Contractor's liability under governing laws or the warranty specified in the General Conditions.
    d. In the written guaranties and warranties, indicate the products and performance covered, the remedy in the event of failure of the product or process to perform as specified, and the length of the warranty and guaranty period.
    e. Such guaranties and warranties shall run for the entire period specified to the

Owner and the then current Owner, regardless of any transfer of ownership of the Project, or portions thereof, by sale, assignment, act of law, or otherwise.

2. Manufacturer Special Warranty: Where a manufacturer's special warranty is required in the technical specifications, manufacturer shall warrant, to the Owner and Contractor, all of his work in accordance with the requirements of the technical specifications and this Section. Provide such in writing, signed by an officer of the manufacturer, for a period commencing at the date of substantial completion and as specified in the technical specifications. Contractor shall be jointly and severally liable with manufacturer for all requirements of manufacturer's special warranty.
3. Installer's Special Guaranty and Warranty: Where an Installer's special guaranty and warranty is required in the technical specifications, Installer shall comply with all of the requirements set forth in the Installer Special Guaranty and Warranty form at the end of this Section. Installer shall complete and submit such form. Contractor shall be jointly and severally liable with Installer for all requirements of Installer's special guaranty and warranty.

1.5 SPARE PARTS AND MAINTENANCE MATERIALS

A. Extra Stock: Where the basic unit of material supplied is in boxes, packages, cans or other containers, supply a minimum of one complete container. Where the material is yard goods, turn over all excess material (except small scraps) to the Owner for extra stock, in addition to specified amounts. In each case, supply at least one unit or item of each type, size, material and color used in the work from the same manufactured lot as the materials installed.

B. Submit a list of all spare parts provided in a Table with the description, number of parts, specification, related piece of equipment, and location stored.

1.6 RESTORATION OF SITE

A. Where portions of the Site, either inside or outside the Contract Limit Lines, are not designated for change or new work and become damaged during the course of construction due to operations arising from work under this Contract, repair or replace such damage in conformance with the Contract Documents for like or similar work. If the Contract Documents do not contain like or similar work, repair or replace such damaged areas as required to their original condition.

1.7 SUBSTANTIAL COMPLETION

A. When the work is substantially complete, submit:
   1. A written notice that the work, or designated portion thereof, is substantially complete
   2. A list of items to be completed or corrected. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all work in accordance with the Contract Documents.

B. Engineer will then make an inspection to determine the status of completion.

C. If Engineer determines that the work is not substantially complete, he will notify the Contractor in writing, listing the reasons.
   1. Correct all items listed and send a second written notice of substantial completion to Engineer.
   2. Engineer will reinspect the work.

D. When Engineer determines that the work or designated portion thereof is substantially complete, he shall:
   1. Prepare a Certificate of Substantial Completion, accompanied by Contractor's list of items to be completed or corrected as verified and amended by the Engineer. Such certificate shall establish the Date of Substantial Completion, shall state the responsibilities of the Owner and the Contractor for security, maintenance, heat utilities, damage to the work, and insurance, and shall fix the time within which the Contractor shall complete the items on the above lists.
   2. Submit the Certificate of Substantial Completion to Owner and Contractor for their written acceptance of the responsibilities assigned to them in the Certificate.

E. When the Owner concurs that the work is substantially complete, he will accept the Contractor's list of items to be completed or corrected as amended by the Engineer and, under terms of the Contract Documents, occupy the Project or portion thereof.

1.8 FINAL INSPECTION

A. When the work or designated portion thereof is complete, submit written certification that:
   1. All items on the above list have been completed or corrected.
   2. Contract Documents have been reviewed
   3. Work has been inspected for compliance with Contract Documents
   4. Work has been completed in accordance with Contract Documents
   5. Equipment and systems have been tested in the presence of the Owner and are operational
   6. Work is completed and ready for final inspection

B. Upon receipt of written notice that the work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, Engineer shall promptly make such final inspection.

C. If Engineer considers the work incomplete or defective, he will promptly notify the Contractor in writing, listing the incomplete or defective work.
   1. Contractor shall take immediate steps to remedy the stated deficiencies and shall send a second written certification to Engineer that the work is complete.
   2. Engineer will reinspect the work.

D. During the final inspection, demonstrate all operable equipment and other moving parts. Make all adjustments to the satisfaction of the Owner.

E. When Engineer finds that the work is acceptable under the Contract Documents, he will request the Contractor to make closeout submittals.

1.9 REINSPECTION FEES

A. Engineer will not be obligated for work beyond the scope of the Owner- Engineer Agreement. If Engineer is required to perform reinspection due to failure of the work to comply with the claims of status of completion made by the Contractor:
   1. Owner shall compensate Engineer for such Additional Services and Owner shall deduct the amount of such compensation from Final Payment to Contractor.

1.10 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting with adjustments to the Contract Sum and include:
   1. The original Contract Sum.
   2. Additions and deductions resulting from:
      a. Previous Change Orders.
      b. Allowances.
      c. Unit Prices.
      d. Deductions for uncorrected work.
      e. Deductions for liquidated damages.
      f. Deductions for reinspection payments.
      g. Other adjustments.
   3. Total Contract Sum, as adjusted.
   4. Previous payments.
   5. Sum remaining due.

B. A final Change Order will be prepared reflecting adjustments to the Contract Sum not previously made by Change Orders.

1.11 FINAL APPLICATION FOR PAYMENT

A. Submit the final Application for Payment in accordance with requirements stated in the Conditions of the Contract.

1.12 DELIVERY OF DOCUMENTS

A. With the final Application for Payment and before the final Certificate of Payment will be issued, submit As-Built Drawings, Project Manual, and all O&M Manuals.

END OF SECTION 01 7700

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SECTION 01 7823

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 REFERENCES

A. The requirements of Division 01 apply to the work of all other Sections.

1.2 GENERAL

A. Submittal of operation and maintenance data shall be made to the Engineer on specified product items as outlined herein.

1.3 OPERATION AND MAINTENANCE MANUALS

A. Required where specified in technical sections.

B. Submit written instructions for operating each piece of equipment and for maintaining equipment. At the time of inspection for substantial completion, Engineer will notify Contractor of any revisions, corrections or incomplete data required for the satisfactory completion of the Operation and Maintenance Data Reference Manual. Engineer will not recommend final acceptance of the work until the Operation and Maintenance Data Reference Manual is complete and satisfactory to him.

C. Submit Operations and Maintenance Manuals when the equipment is delivered to the Job Site. Failure to deliver manuals may be cause to withhold payment for equipment.

D. The Operation and Maintenance Data Reference Manual shall contain, but is not limited to, the following information on all equipment and accessories furnished and installed under these Specifications:
   1. Equipment function, normal operating characteristics and limiting conditions for all equipment furnished.
   2. Detailed assembly, installation, alignment, adjustment and checking instructions for all equipment furnished.
   3. Detailed operating instructions for start-up, calibration, routine and normal operations, regulation and control, shutdown and emergency conditions for all equipment furnished.
   4. Detailed lubrication instructions and schedules for all equipment furnished including identification of lubricant (description, specification and trade name of at least two manufacturers), and diagrams illustrating lubrication points.
   5. Detailed guide to "troubleshooting" for all equipment furnished.
   6. Detailed parts lists identified by generic title, materials of construction and part number (actual manufacturer's number, not supplier's), list of recommended spare parts identified as specified above, predicted life of parts subject to wear and an exploded view of each equipment assembly for all equipment furnished.
   7. Electrical and instrumentation schematics for all equipment furnished including motor control centers, control panels, instrument panels and analyzer panels.
   8. List of all special tools required and description of their use for all equipment furnished. Special tools include any tool not normally available in an industrial hardware store.

9. Detailed preventive maintenance procedures and schedules for all equipment furnished.
10. Detailed list of settings for relays, pressure switches, temperature switches, level switches, thermostats, alarms, relieve valves, rupture discs, etc.
11. List of names and addresses of nearest service centers for parts, overhaul service.
12. One copy of any instructions and parts lists attached to equipment when delivered.
13. Procedures for storing, handling and disposing of any chemicals or products used with the equipment or system.

E. Assembly of Operation and Maintenance Data Reference Manual
1. Submit 1 preliminary copy of each manual in electronic PDF format to Engineer prior to date of shipment of the equipment
2. Three (3) final copies of each O&M manual shall be submitted, directly to the Owner, using loose-leaf binders. Binders shall be three-ring, hardback type, with a transparent vinyl pocket on the spine for label.
3. Each copy of the data reference manual shall be assembled in one or more loose-leaf binders, each with title page, typed table of contents, typed list of tables, typed list of figures and heavy section dividers with copper or mylar reinforced holes and numbered plastic index tabs. All data shall be punched for binding and composition and printing shall be arranged so that punching does not obliterate any data. The binding edge of each manual shall have the project number and title, specification division number and title and manual title printed thereon, all as approved by the Engineer.
4. List for each product, the name, address, and telephone number of the Subcontractor, Maintenance Contractor and source of supply.
5. Products not installed shall be removed from the Manual.
6. Provide manufacturer's recommended cleaning materials and methods.
7. All copies of Shop Drawings, figures and diagrams shall be reduced to either 8 1/2 by 11 inches or to 11 inches in the vertical dimension and as near as practicable to 17 inches in the horizontal dimensions. Fold such sheets to 8 1/2 by 11 inches. Print the manual and other data on first quality paper, 8 1/2 by 11 inch size with standard three-hole punching. Reduce drawings and diagrams to 8 1/2 by 11 inches or 11 by 17 inches. Label binders Vol. 1, Vol. 2, etc., where more than one is required. The table of contents for the entire set, identified by volume number, shall appear in each binder. Text, figures and drawings shall be clearly legible and suitable for dry process reproductions.

F. Electronic Format
1. The Contractor shall provide a USB drive(s) containing all the elements of each approved O&M Manual.
2. The contents of the electronic format shall be the same as the approved O&M Manual.
3. All text based documentation (i.e., specs, O&M, MSDS sheets, data sheets, etc.) shall be delivered on the USB drive in PDF format.
4. All pictures, graphs, or anything that is not a drawing shall be delivered on the USB drive in either a TIFF, JPEG, or GIF format.
5. All CAD drawings shall be delivered on the USB in AutoCAD 2016 or higher format.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 7823

SECTION 02 4100

DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition within the existing Sodium Hypochlorite Room of the existing Chemical Feed Building.
   2. Demolition within the existing Poly Ortho Room of the existing Chemical Feed Building.
   3. Demolition of the existing Fluoride Room of the existing Chemical Feed Building.
   4. Demolition of existing structures that currently exist where the new NF building is proposed to be constructed.
   5. Disconnecting, capping or sealing, and abandoning in-place site utilities and process piping.

1.2 MATERIALS OWNERSHIP

A. Owner shall have right of first refusal on existing equipment.

B. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.3 SUBMITTALS

A. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, and for dust control. Indicate proposed locations and construction of barriers.
   1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.

B. Schedule of Demolition Activities: Indicate the following:
   1. Detailed sequence of demolition work, with starting and ending dates for each activity.
   2. Temporary interruption of utility services.
   3. Shutoff and capping of utility services.

C. Inventory: Submit a list of items to be removed and deliver to Owner prior to start of demolition.

D. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by demolition operations. Submit before the Work begins.

E. Outage Request: Submit an Outage Request at least 72 hours before demolition is to begin.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

1.5 PROJECT CONDITIONS

A. Structures immediately adjacent to demolition area will be in service. Conduct demolition so operation of treatment plant will not be disrupted, unless an outage request has been approved by the Owner.
   1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent structures and equipment.
   2. Maintain access to existing walkways, exits, and other facilities used by treatment plant operator.

B. Owner assumes no responsibility for structures to be demolished.
   1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

D. On-site storage or sale of removed items or materials is not permitted.

1.6 COORDINATION

A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

1.7 SCHEDULING

A. Demolition within the existing chemical feed building at RARWTP must take place from November 1 to April 30.

B. Conduct work so as to avoid interference with operations and work in the existing facilities.

C. Include provisions for temporary services, as required, to ensure no interruption of OWNER operations.

D. Before any demolition work begins, obtain approval of all necessary outage requests 72 hours prior to commencement of work. Do not start any equipment removal or demolition operations without the concurrence of the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.

D. Verify that hazardous materials have been remediated before proceeding with demolition operations.

E. Review with the Engineer, the exact areas where the existing railing is to be removed.

3.2 PREPARATION

A. Existing Piping and Utilities: Locate, identify, disconnect, and seal or cap off indicated piping and utilities serving buildings and structures to be demolished.
   1. Owner will arrange to shut off indicated utilities when requested by Contractor.
   2. If removal, relocation, or abandonment of services will affect treatment plant operations, then provide temporary services that bypass structures to be demolished and that maintain continuity of service to other structures.
   3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

B. Existing Utilities: Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
   1. Strengthen or add new supports when required during progress of demolition.

D. Salvaged Items: Comply with the following:
   1. Clean salvaged items of dirt and demolition debris.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to storage area designated by Owner.
   5. Protect items from damage during transport and storage.

E. Sequence of Demolition
   1. Existing chemical feed facilities must remain fully operational at all times.
   2. Contractor to provide temporary feed systems, if required. Temporary feed systems must be fully automated (tied into SCADA).

3.3 PROTECTION

A. Existing Facilities: Protect adjacent walkways, building entries, and other facilities during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
   1. Do not interrupt existing utilities serving adjacent operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
   2. Provide temporary services during interruptions to existing services, as acceptable to Owner and authorities having jurisdiction.

a. Provide at least 72 hours' notice to treatment plant operator if shutdown of service is required during changeover.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated.
1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
4. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
5. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

E. Existing piping and equipment might be pressurized or contain various amounts of their original contents, sediments or grit, or might contain pockets of trapped gas, or other by-products common to the facilities. Exercise care in commencing the removal of any segments of piping or equipment and ventilate the pipes. Do not use cutting torches or abrasive cutting wheels until after ventilating the pipelines and verifying that they are free of volatile substance.

3.4 DEMOLITION, GENERAL

A. General: Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain fire watch during and for at least 2 hours after flame cutting operations.
3. Maintain adequate ventilation when using cutting torches.
4. Locate demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

C. Explosives: Use of explosives is NOT permitted.

3.5 DEMOLITION BY MECHANICAL MEANS

A. Below-Grade Construction: Remove below-grade construction to at least 48 inches below existing grade.

B. Tank floors shall be adequately cracked and busted by means of jackhammer or other methods to prevent accumulation of water following abandonment of the tanks.

C. Debris from partial tank wall demolition may be placed in the bottom of the tank.

D. Remainder of tank void shall be filled with suitable soil. Additional construction waste and other unsuitable materials, such as boulders, wood, and piping shall not be used. Compact soil in lifts not to exceed 24-inches using mechanical soil compaction equipment. Refer to Paragraph 3.7 for additional site restoration requirements.

E. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
   1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

3.6 PIPE DEMOLITION/ABANDONMENT

A. Buried Piping shown to be demolished may be abandoned in place if it does not interfere with new construction.

B. Furnish and install 12-inch minimum plug at each end of abandoned pipe. For pipes larger than 2-inch diameter, provide concrete plug. For pipes 2-inch diameter and smaller, provide non-shrink grout plug. All pipes noted on the Drawings to be abandoned that are 8-inch in diameter and larger shall be plugged and have the internal void filled with controlled density fill mix.

3.7 SITE RESTORATION

A. Below-Grade Areas: Completely fill below-grade areas and voids resulting from demolition operations with satisfactory soil materials. The top 6 inches of fill shall consist of topsoil.

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

C. If noticeable settling of the soil in the demolition area occurs during a period of up to one year following final construction completion, the contractor shall provide additional soil fill and perform re-grading and seeding at no additional cost to the owner.

3.8 REPAIRS

A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.9 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove excess demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.10 CLEANING

A. Following demolition and site grading, clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

END OF SECTION 02 4100

SECTION 02 6500

UNDERGROUND STORAGE TANK DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the removal of an existing underground fuel storage tank.

1.2 QUALITY ASSURANCE

A. Permits and Regulations: The Contractor shall obtain all necessary permits and licenses required for underground storage tank removal.

B. Underground storage tank demolition shall be in compliance with applicable requirements of the following:
   1. American Petroleum Institute (API)
   2. United State Environmental Protection Agency (USEPA)
   3. State Fire Marshall
   4. Bureau of Underground Storage Tanks (BUSTR)
   5. Occupational Safety and Health Administration (OSHA)
   6. Any other governing authority having jurisdiction

1.3 STORAGE, HANDLING, AND REMOVAL

A. Title to Materials: All tanks, piping, and related items to be removed shall become the property of the Contractor after they have been removed from the site.

B. Salvageable Items: The Contractor shall carefully remove items to be salvaged, if any, and store them on site in an approved location. Items shall remain the property of the City.

C. Reused Materials: The Contractor shall remove and store material to be reused or retained in a manner which prevents damage to the material.

D. Marking Excavated Tanks: Prior to permanent disposal, the Contractor shall clearly mark the tanks by painting the outside with the following wording:

TANK HAS CONTAINED OIL (or other applicable name)
NOT OIL FREE
NOT SUITABLE FOR FOOD OR DRINKING WATER

E. Removal and Disposal of Tank Contents: Tank contents, cleaning solutions, rinse water, and contaminated clothing and equipment shall require a waste analysis, and shall be disposed of according to applicable regulations and General Specifications 02105 and 02316. The tank and all the other contents shall be removed from the site for disposal in accordance with the requirements of the local codes and regulations. Disposal shall be completed within 72 hours of obtaining analytical results.

1.4 FIELD CONDITIONS

A. Underground storage tank to be removed is located at the Richard A. Renneker WTP in Maineville, Ohio.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor shall pump out all remaining liquid in the tank. Following removal of the liquids, the tank shall be purged and tested to assure that no explosive gases are present. Any liquid present in underground piping shall be properly drained and piping purged prior to removal. The tank atmosphere shall be tested to determine if the tank is safe. The tank interior shall be tested for percent oxygen per volume and for percent of lower explosive limit (LEL). The tank atmosphere shall be greater than 19% oxygen and less than 25% LEL before the tank is considered safe. If the tank is not safe, then inerting and purging must be continued until the tank passes all testing.

B. Pipe Cleaning: After the tank is emptied, the tank and all connecting piping to the tank shall be cleaned and triple rinsed in accordance with all applicable local regulations regarding underground storage tank cleaning and API Accident Prevention Manual No. 1A. The Contractor shall dispose of all removed liquids in a method conforming to all applicable Federal, State, and local regulations. The Contractor shall provide protective measures around the excavation area to prevent water runoff.

C. Disconnecting Piping: The Contractor shall disconnect piping from all tank openings, and cap or plug all tank openings. All piping shall be removed and disposed of as specified.

D. Excess Liquid: Residual liquid remaining in the tank shall be absorbed by sawdust or fine sand introduced into the tank or other approved method. The Contractor shall dispose of absorbing material in accordance with all applicable State and local regulations. The tank shall not be moved if liquid is still present in the tank. Preventive measures shall be taken to avoid liquid leaking from the tank or associated piping into the excavation area.

E. Initial Tank Cleaning: Initial tank cleaning, prior to tank removal, shall be conducted as follows:
   1. Introduce water into the high end of the tank. Pump water, along with any remaining product or sediment, out of the lower end of the tank.
   2. During the initial cleaning operations, the following items shall be observed:
      a. The pumps or vacuum lift used in the operation shall be properly grounded and bonded.
      b. Vapors from the vacuum vent system shall be emitted a minimum height of 12 feet above grade and 3 feet above any adjacent structure in accordance with API standards.
      c. Explosive vapors may develop during cleaning procedures. The area in and around the tank site shall be monitored continuously with direct reading on-line meters for flammable or combustible vapor and total volatile vapor concentrations until the tank is removed from the excavation and the site.
   3. If the vapor concentration exceeds 25% LEL, all work shall be stopped until vapors disperse.

4. Response to any vapor concentration (total and LEL) condition shall be in accordance with the Contractor's Health and Safety Plan.
5. All smoking and other ignition sources are prohibited from the tank area at all times.
6. Maintain operable fire extinguishers on site at all times in accordance with the Health and Safety Plan.

F. Secondary Cleaning: Secondary cleaning procedure involves actual entry into the tank for manual cleaning.
1. Create a large opening into the tank as required by the confined space entry provisions of the Health and Safety Plan.
2. During secondary cleaning operations, the following items shall be observed:
   a. All confined space entry safety precautions and requirements shall be met.
   b. Enter tank only when UST is deemed safe based on monitoring information.
   c. Remove all remaining sludge, tar, scaling, etc., using a squeegee. All remaining residue shall be pumped from the bottom of the tank, or absorbed with suitable absorbent material.
   d. All residual material shall be recovered, characterized, drummed, labeled and disposed of in accordance with all local rules and regulations.
   e. Inspect the interior wall of the tank for holes or breaks.

G. Gas Freeing Tanks: USTs and piping shall be rendered vapor free before removal is initiated. All tanks and piping must be certified gas and vapor free by an approved marine chemist prior to requesting Hot Work Permits. The USTs shall be inerted below the specified State and local approved acceptable LEL in accordance with all applicable Federal, State and local codes and regulations and API recommended procedures. The Contractor shall dispose of any water used in the gas-freeing operation in accordance with applicable regulations and the Detailed Specifications. USTs and piping shall be adequately grounded so that buildup of any static charge is prevented. The Contractor shall remove the tank from the property immediately upon completion of the gas-freeing operation.

H. Gas-free the tank using one of the procedures described in API Bulletin 1604, Recommended Practice for Abandonment or Removal of Used Underground Service Station Tanks.

3.2 REMOVAL

A. Tank Excavation: The Contractor shall excavate to the tank and carefully remove tank from the ground. As much adhering soil as possible shall be removed from the tank, and the tank shall be placed on plastic sheeting in a secure location, covered with plastic sheeting, and blocked to prevent movement. Soil removed from the exterior of the tank, as well as during excavation, shall be tested and disposed of off-site in accordance with the NYS DEC STARS Memo No. 1, all applicable Federal, State, and local regulations, and General Specification 02105. Soil shall be excavated to facilitate tank removal only. Once tank is removed from the ground, all excavation shall cease.

B. Testing along Piping: The Contractor shall provide testing along piping for all tanks with odor or staining of soil. The Contractor shall take one soil sample for every 25 linear feet of product delivery piping.

C. Encountered Contamination: Contractor shall notify the Engineer, verbally, within one hour of any contamination encountered, and shall provide a follow-up notification to the Engineer, in writing, within 1 day. Any spills or drips shall be contained to the maximum extent possible to

minimize the spread of encountered contamination. Failure to notify the Engineer will subject the Contractor to additional liability if the encountered contamination spreads in any way.

3.3 REMOVAL

A. All accessible holes shall be plugged or capped. The tank shall be rendered unusable for further use in accordance with API Bulletin 1604. Immediately remove demolished material from site. In no case shall a removed tank remain on-site for a period of time exceeding 24 hours.

B. All UST systems being permanently removed shall comply with the cleaning, removal, and safety requirements of American Petroleum Institute Recommended Practice RP 1604-96 (reaffirmed 2010); "Closure of Underground Petroleum Storage Tanks" and National Institute for Occupational Safety and Health Publication 80-106 (1979); "Criteria for a Recommended Standard: Working In Confined Spaces".

C. The UST shall be maintained in a safe condition by regularly monitoring the UST to ensure that an accumulation of explosive vapors does not occur.

D. All liquid and residue shall be removed from the UST before the UST leaves the site and handled in accordance with the following:
   1. The handling, transportation, and disposal of any regulated substance removed from an UST system, regulated soil, backfill materials, groundwater, wash water, or other similar materials removed from the system or facility shall be managed in accordance with all applicable federal, state, and local regulations in effect for the type, volume, constituent concentration, and classification of the material.

E. The UST shall be rendered unusable and free of explosive vapors before the UST leaves the site by cutting up or crushing the UST or by perforating the UST with numerous holes using explosion-proof non-sparking tools. No UST shall be reused for any purpose unless written approval is obtained from the state fire marshal prior to the removal activity.

F. All backfill from the tank cavity excavation, piping trenches, dispensing unit areas, and remote fill pipe trenches shall be removed.

G. No more than twelve inches of native soil shall be removed from the side walls and bottom of the tank cavity excavation, piping trenches, dispensing unit areas, and remote fill pipe trenches. Where bedrock is encountered within the first twelve inches, remove native soil to bedrock. Further removal of soil from the tank cavity, piping trenches, dispensing unit areas, and remote fill pipe trenches for purposes of corrective action shall not be conducted without prior approval of the state fire marshal and the Engineer.

H. Backfill and native soil removed from the tank cavity excavation, piping trenches, dispensing unit areas, and remote fill pipe trenches may be stored on site in a stockpile for a period not to exceed one hundred twenty days, provided that it has been placed on a concrete pad, asphalt pad, or impermeable synthetic liner, covered to prevent infiltration of rain water, and has been surrounded with a berm to minimize the run off water. Storage on site beyond one hundred twenty days shall only occur if prior approval has been granted by the state fire marshal. Backfill and native soil shall be handled in accordance with the following:
   1. The handling, transportation, and disposal of any regulated substance removed from an UST system, regulated soil, backfill materials, groundwater, wash water, or other similar materials removed from the system or facility shall be managed in accordance with all

applicable federal, state, and local regulations in effect for the type, volume, constituent concentration, and classification of the material.

I. If free product is discovered during removal of any portion of an UST system, Contractor shall report a suspected release to the state fire marshal within twenty-four hours and proceed to conduct corrective action in accordance with paragraph (F) of rule 1301:7-9-13 of the Ohio Administrative Code.

J. Backfilling UST Excavations: Prior to backfilling, the Contractor shall provide the location and analytical results of all samples collected to the Engineer. The Contractor shall protect the excavation at all times by whatever means necessary to ensure that all safety requirements are met. Backfilling shall be in accordance with Division 31, Section "Excavation and Fill", and may not be commenced without approval of the Engineer.

END OF SECTION 02 6500

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SECTION 03 1100

CONCRETE FORMING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete forming. The Work also includes:
a. Designing forming systems in accordance with requirements of ACI 347 and the Contract Documents.
b. Providing forming to accommodate the Work under this and other Sections and building into forming items such as sleeves, anchorage devices, inserts, pipe embedments, reinforcing, and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before concrete forming Work.
2. Coordinate forming Specifications with requirements for finished surfaces specified in Section 03 3000, Cast-In-Place Concrete.

C. Related Sections:
1. Section 03 1500, Concrete Accessories.
2. Section 03 3000, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
2. ACI 301, Specifications for Structural Concrete.
3. ACI 347, Guide to Formwork for Concrete.
4. ASTM C1074, Practice for Estimating Concrete Strength by the Maturity Method.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Professional Engineer:
a. Contractor or formwork Supplier shall retain a registered professional engineer legally qualified to practice in same state as the Site. Professional engineer shall have at least five years' experience designing formwork and falsework of the type required.
b. Responsibilities include:
1) Reviewing formwork and falsework performance and design criteria stated in the Contract Documents.

2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
3) Preparing or supervising preparation of design calculations verifying compliance of formwork and falsework with requirements of the Contract Documents.
4) Signing and sealing all calculations.
5) Certifying that:
    a) Design of formwork and falsework was performed in accordance with performance and design criteria stated in the Contract Documents, and
    b) Design conforms to all Laws and Regulations, and to prevailing standards of practice.
    c) In place falsework, prior to concrete placement, complies with the intent of the forming design and complies with the Contract Documents.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Samples:
        a. Plywood form material used for smooth form finish, four inches square minimum.

B. Informational Submittals: Submit the following:
    1. Shop Drawings: When requested by Engineer, submit Shop Drawings showing and indicating general construction of individual forms, including:
        a. Special formed joints or reveals.
        b. Location, pattern, and details of form tie placement, removal, and repair procedures.
        c. Location and details for temporary openings.
        d. Other items that would visually affect the finished concrete.
    2. Design of Temporary Measures: Design of formwork and falsework is Contractor's responsibility. Submit the following:
        a. Falsework layout drawings with the seal and signature of Contractor's or Supplier's professional engineer. Layout drawings shall show bracing details, waler arrangements, location of shores, joint forming details, and details at connections to previously placed concrete. Engineer's review will be for general conformance to the requirements of the Contract Documents and ACI 347, as indicated for delegated design in the General Conditions.
        b. Design calculations for formwork and falsework, when requested by Engineer.
        c. Certification letter from Contractor's or Supplier's professional engineer stating that in-place falsework was inspected and complies with the intent of the falsework design.
    3. Product Data: Manufacturer's data for proprietary materials, including form coatings, manufactured form systems, ties and accessories.
    4. Manufacturer's Instructions: Installation instructions for proprietary materials, including form coatings, manufactured form systems, ties and accessories.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage:
    1. Upon delivery to the Site, place materials in area protected from weather.
    2. Store materials in accordance with manufacturer's recommendations.

3. Store materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.

B. Handle materials in accordance with the manufacturers' recommendations. Do not damage materials during handling.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
1. Design, erect, support, brace and maintain forming in accordance with ACI 347 so that forming safely supports vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by forming system or in-place construction that has attained adequate strength for the purpose. Construct forming so that concrete members and structures are of correct size, shape, alignment, elevation, and position.
2. Design forms and falsework to include values of live load, dead load, weight of moving equipment operated on forming, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
3. Provide shores and struts with positive means of adjustment capable of taking up forming settlement during concrete placing operations, using wedges or jacks, or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.
4. Support form facing materials by structural members spaced sufficiently close to prevent beyond tolerance deflection, in accordance with ACI 117. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances. For long-span members without intermediate supports, provide camber in forming as required for anticipated deflections resulting from weight and pressure of fresh concrete and construction loads.
5. Design and construct forming to be readily removable without impact, shock or damage to concrete surfaces and adjacent materials.
6. Provide forming sufficiently tight to prevent leakage of cement paste during concrete placing. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.
7. Omit side forms of footings and place concrete directly against excavation only when requested by Contractor in writing and accepted by Engineer in writing. When omission of forms is accepted, provide additional concrete required beyond minimum design profiles and dimensions of footings as shown or indicated on the Drawings. No additional compensation will be paid to Contractor for additional concrete required.

2.2 FORM MATERIALS

A. Forms for Smooth Finish Concrete:
1. Unless otherwise shown or indicated in the Contract Documents, construct forming for smooth concrete surfaces with plywood, metal, metal-framed plywood-faced, or other panel type materials acceptable to Engineer, to provide continuous, straight, smooth as-cast surfaces with no wood grain or other surface texture imparted by forming. Provide in largest practical sizes to minimize number of joints and to conform to joint system shown

or specified in the Contract Documents. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Standard Finish Concrete:
   1. Form concrete surfaces designated to have standard formed finish with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least two edges and one side.

C. Cylindrical Columns and Supports:
   1. Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
      a. Provide manufacturer's standard plastic-lined-interior units.
   2. Fiberglass or steel forms may be used for cylindrical columns if accepted by Engineer in writing.

D. Form Coatings:
   1. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds. For concrete surfaces that will be in contact with potable water or water that will be treated to become potable, form coating shall be a mineral oil base coating.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which the Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 FORM CONSTRUCTION

A. Construct forms in accordance with ACI 347; to the exact sizes, shapes, lines, and dimensions shown; as required to obtain accurate alignment, location, and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be in accordance with approved mock-up or sample panel, when specified.

B. Allowable Tolerances:
   1. Construct forming to provide completed concrete surfaces complying with tolerances specified in ACI 117, ACI 301, and ACI 347.
      a. Architectural finish forming, and where shown or indicated on the Drawings, shall be Class A surface, 1/8-inch offset.
      b. Other surfaces exposed to view shall be Class B surface, 1/4-inch offset.
      c. Other surfaces shall be Class C surface, 1/2-inch offset.
   2. Tolerances apply to form offsets and to irregularities within the formed surface when measured with a straightedge over a five-foot distance.

C. Install forming and accessories for facilities in accordance with manufacturer's instructions, Laws and Regulations, and the Contract Documents.

D. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.

E. Provide temporary openings where interior area of forming is inaccessible for cleanout, for inspection before concrete placement, and for placing concrete. Brace temporary closures and set tightly to forms to prevent loss of cement paste. Locate temporary openings on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

F. Falsework:
   1. Erect falsework and support, brace, and maintain falsework to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct falsework so that adjustments can be made for take-up and settlement.
   2. Provide wedges, jacks or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce finished Work of required dimensions.

G. Forms for Smooth Finish Concrete:
   1. Do not use metal cover plates for patching holes or defects in forms.
   2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
   3. Use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
   4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
   5. Form molding shapes, recesses, rustication joints and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

H. Corner Treatment:
   1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown or indicated in the Contract Documents. Chamfer exposed corners.
   2. Form chamfers with 3/4-inch by 3/4-inch strips, unless otherwise shown or indicated in the Contract Documents, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Use rigid PVC chamfers for architecturally formed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
   3. Reentrant or internal and unexposed corners may be formed either square or chamfered.

I. Joints:
   1. For joint treatment, comply with Section 03 1500, Concrete Accessories. Locate joints as shown and specified.

J. Openings and Built-In Work:
   1. Provide openings in concrete forming shown or required under other Sections or other contracts. Refer to Paragraph 1.1.B of this Section for coordination requirements.
   2. Accurately place and securely support items to be built into forms.

K. Sealing Forming:
   1. Forming joints shall be tight-fitting or otherwise sealed to prevent loss of cement paste.
   2. Provide forming resting against concrete surfaces with compressible gasket material between the concrete and edge of form, to fill irregularities and create tight seal.

L. Cleaning and Tightening:
   1. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed. Retighten forms immediately after placing concrete, as required to eliminate cement paste leaks.

M. Tie Hole Repair:
   1. Repair tie holes in accordance with Section 03 3000, Cast-In-Place Concrete.

3.3 FORM COATINGS

A. Coat form contact surfaces with non-staining form-coating compound before installing reinforcing materials. Do not allow excess form coating material to accumulate in forms or come into contact with surfaces that will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with non-staining, rust-preventative form oil, or otherwise protect against rusting. Do not use rust-stained steel forming.

C. For concrete surfaces that will be in contact with potable water or water that will be treated to become potable, form coating shall be mineral-oil base coating.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Set and build into forming anchorage devices and other embedded items, shown, specified, or required under other Sections. Refer to Paragraph 1.1.B of this Section for coordination requirements. Use necessary setting drawings, diagrams, instructions, and directions.

B. Edge Forms and Screeds Strips for Slabs:
   1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support screeds.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Before placing concrete, check ties, tie cones, tie waterstops, embedded items, form coatings, forming stability, alignment, and tolerances. Make corrections and adjustments to ensure forming complies with intent of the forming design, proper stability of forming systems, and accurate size and location of concrete members.
   2. During concrete placing, check forming and related supports to ensure that forms are not displaced and that completed Work will be within specified tolerances.

3. If forms are unsatisfactory in any way, either before or during concrete placing, stop or postpone placing of concrete until defects are corrected as required by Contractor's or Supplier's professional engineer and accepted by Engineer.

3.6 REMOVAL OF FORMS

A. Determination of time between placing concrete and removing forms is Contractor's responsibility. Requirements specified in this Section are minimum times and requirements intended to ensure that concrete will support its own weight, and do not consider additional effects of the construction. Additional effects of the construction shall be accounted for by Contractor when determining time for removing forming. Time for removing of forms is subject to Engineer's acceptance.

B. Comply with requirements of ACI 301 and ACI 347, except as indicated in the Contract Documents.

C. Removal of Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges:
1. Comply with requirements of Table 03 1000-A of this Section:

TABLE 03 1000-A, REMOVAL OF FORMS

Component	Average Daily Ambient Air Temperature (deg F)				Min. Concrete Compressive Strength for Form Removal
	Over 70 F	60 F to 70 F	50 F to 60 F	Below 50 F	
Walls	One day	Two days	Three days	See Paragraph 3.6.C.2 of this Section	750 psi
Columns	Two days	Three days	Four days		1000 psi
Side of beams and girders	One day	One day	Two days		500 psi
Slab and foundation edges	One day	One day	Two days		500 psi

2. When average daily ambient air temperature is below 50 degrees F, do not remove forms until concrete attains minimum compressive strength indicated in Table 03 1000-A for form removal, and comply with Paragraph 3.8.C.3.b of this Section.
3. Concrete Strength Requirements for Form Removal:
   a. For other than beams and elevated slabs, do not remove forms until concrete attains minimum concrete compressive strength indicated in Table 03 1000-A for form removal.
   b. For beams and elevated slabs, do not remove supporting forms or shoring until concrete attains minimum of 90 percent of its specified compressive strength.

D. Alternative Criteria for Removing Forms for Walls, Columns, Sides of Beams and Girders, and Slab and Foundation Edges: Contractor has the option of submitting an alternative removal of

forms table, together with supporting data, for Engineer's acceptance. Supporting data shall include representative field data for each different placement ambient temperature condition and minimum of three tests per temperature condition to ensure that accurate correlation between concrete strength and placement temperature is obtained.

E. Determination of In-place Concrete Strength:
   1. Determine compressive strength of in-place concrete by compression test specimens cured at the Site under the same conditions of temperature and moisture as the concrete member under consideration.
   2. Alternately, determine compressive strength of in-place concrete by maturity factor procedure in accordance with ASTM C1074 and approved by Engineer. Location of embedded thermistors or thermocouples shall be as approved by Engineer.

F. When high-early strength concrete is used, time for removing the forms will be developed at the Site from the age/strength relationships established for the materials and proportions used by tests in accordance with ACI 301.

G. Continue curing, including bottom surfaces of slabs and beams, after form removal in accordance with Section 03 3000, Cast-In-Place Concrete.

3.7 PERMANENT SHORES

A. Provide permanent shores in accordance with ACI 347.

B. Reshores are not allowed.

3.8 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the construction. Do not use split, frayed, delaminated, or otherwise damaged form facing material. Apply form coating compound material to concrete contact surfaces as specified for forming.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces. Form surfaces are subject to Engineer's approval.

END OF SECTION 03 1100

SECTION 03 1500

CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete accessories.

B. Related Sections:
   1. Section 03 1100, Concrete Forming.
   2. Section 03 6000, Grouting.
   3. Section 07 9200, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 301, Standard Specifications for Structural Concrete.
   2. ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   3. CRD-C572, U.S. Army Corps of Engineers Specifications for Polyvinyl- Chloride Waterstop.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layout of construction and expansion joint locations. Submit and obtain approval prior to submitting concrete reinforcement Shop Drawings.
      b. For construction and expansion joints that require waterstops, submit layout of locations showing waterstop details. Indicate waterstop type, waterstop joint conditions, and details on how joint conditions will be handled.
   2. Samples:
      a. Submit Sample, at least six inches long each, of each type of waterstop proposed for use.
      b. Submit Sample of foam rubber and cork expansion joint fillers.
      c. Submit Sample of each type of prefabricated PVC waterstop joint.

B. Informational Submittals: Submit the following:
   1. Manufacturer’s Instructions: Manufacturer’s specifications and installation instructions for all materials required.

1.4 DELIVERY, STORAGE AND HANDLING

A. Transportation and Handling of Products:
   1. Deliver materials to Site to ensure uninterrupted progress of the Work.
   2. Comply with Section 01 6000, Product Requirements.

B. Storage and Protection:
   1. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight. Comply with manufacturer's storage and protection requirements.
   2. Comply with Section 01 6000, Product Requirements.

PART 2 - PRODUCTS

2.1 WATERSTOPS

A. Polyvinyl Chloride (PVC):
   1. Material Requirements:
      a. Waterstops shall be extruded from elastomeric PVC compound containing plasticizers, resins, stabilizers, and other materials necessary to meet requirements of the Contract Documents and requirements of CRD-C572. Do not use reclaimed or scrap material.
      b. Tensile strength of finished waterstop: 1,400 psi, minimum.
      c. Ultimate elongation of finished waterstop: 280 percent, minimum.
      d. Minimum thickness shall be 3/8-inch over entire width of waterstop.
      e. Provide waterstops with minimum of seven ribs equally spaced at each end on each side. First rib shall be at the edge. Ribs shall be a minimum of 1/8-inch in height.
      f. Provide waterstops with hog rings or factory-installed grommets anchored to exterior ribs to facilitate tying waterstop in position.
   2. Split waterstops are not allowed.
   3. Construction Joints: Waterstops shall be flatstrip ribbed type, six-inch minimum width, unless otherwise shown or indicated in the Contract Documents.
   4. Expansion Joints: Waterstops shall be centerbulb ribbed type, nine-inch minimum width, unless otherwise shown or indicated in the Contract Documents. Centerbulb shall have minimum outside diameter of 7/8-inch.
   5. Product and Manufacturer: Provide one of the following:
      a. Durajoint Concrete Accessories.
      b. Greenstreak Plastic Products Company.
      c. Or equal.

B. Hydrophilic Waterstop Materials:
   1. General Material Properties:
      a. Bentonite-free, and expandable by minimum of 80 percent of dry volume in presence of water to form watertight joint seal without damaging concrete in which material is cast. Provide only where shown or indicated in the Contract Documents.
      b. Material shall be composed of resins and polymers that absorb water and cause an increase in volume in completely reversible and repeatable process. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
      c. Select materials that are recommended by manufacturer for type of liquid to be contained.
   2. Hydrophilic Rubber Waterstop:
      a. Minimum cross sectional dimensions shall be 3/16-inch by 3/4-inch.
      b. Product and Manufacturer: Provide one of the following:
         1) Hydrotite, by Greenstreak Plastic Products Company.
         2) Or equal.
   3. Hydrophilic Sealant:

a. Hydrophilic sealant shall adhere firmly to concrete, metal, and PVC in dry or damp condition. When cured sealant shall be elastic indefinitely.
b. Product and Manufacturer: Provide one of the following:
   1) Hydrotite, by Greenstreak Plastic Products Company.
   2) Or equal.

2.2 PREFORMED EXPANSION JOINT FILLER

A. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

2.3 CONCRETE CONSTRUCTION JOINT ROUGHENER

A. Provide water-soluble non-flammable, surface-retardant roughener.

B. Product and Manufacturer: Provide one of the following for the types of joints specified:
1. Rugasol-S, by Sika Corporation for horizontal joints only.
2. Concrete Surface Retarder-Formula S, by Euclid Chemical Company, for horizontal joints only.
3. Concrete Surface Retarder-Formula F, by Euclid Chemical Company, for vertical joints only.
4. TK-6100 Concrete Form Surface Retarder, by TK Products.
5. Or equal.

2.4 EPOXY BONDING AGENT

A. Provide a two-component epoxy-resin bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sikadur 32 Hi-Mod LPL, by Sika Corporation.
2. Eucopoxy LPL, by the Euclid Chemical Company.
3. Resi-Bond J-58, by Dayton Superior.
4. Or equal.

2.5 EPOXY-CEMENT BONDING AGENT

A. Provide three component epoxy resin-cement blended formulated as bonding agent.

B. Product and Manufacturer: Provide one of the following:
1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
2. Duralprep A.C., as manufactured by the Euclid Chemical Company.
3. Emaco P24, as manufactured by MBT/ChemRex.
4. Or equal.

2.6 JOINT SEALANT AND ACCESSORIES

A. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07 9200, Joint Sealants.

2.7 CONCRETE BOND BREAKERS

A. Provide asphalt-saturated rag felt building paper, not less in weight than commercially known as 15 pound felt building paper, which weighs 15 pounds per 100 square feet.

B. Chemical Bond Breaker:
   1. Provide medium solids resin solution chemical concrete bond breaker complying with ASTM C309, Type I, Class B.

2.8 RUBBER BONDING AGENT

A. Product and Manufacturer: Provide one of the following:
   1. Scotch-Grip 1300 Rubber Adhesive, as manufactured by 3M Company.
   2. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and installing Subcontractor, if any, shall examine substrate and conditions under which the Work is to be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 CONSTRUCTION JOINTS

A. Comply with requirements of ACI 301 and the Contract Documents.

B. Locate and install construction joints as shown or indicated on the Drawings. Where not shown or indicated, locate joints to not impair strength of the structure; position joints at points of minimum shear. Location of joints shall be approved by Engineer. In addition to joints shown or indicated on the Drawings, locate construction joints as follows:
   1. In foundation mats, locate joints at spacing of approximately 40 feet. Joints shall be located within middle third of element span, unless otherwise shown or indicated on the Drawings. Element span shall be considered distance between piles or, as determined by Engineer, distance between bearing elements, such as columns, exterior walls and interior walls. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.
   2. In walls, locate joints at a maximum spacing of 40 feet. Locate joints away from wall intersections a minimum of one-quarter of the clear span distance between wall intersections measured horizontally.
   3. In structural slabs and beams, joints shall be located within middle third of element span and shall be located in compliance with ACI 301, unless otherwise shown or indicated on the Drawings.
   4. In slabs on grade, locate joints at spacing of approximately 40 feet. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.

C. Horizontal Joints:
   1. Roughen concrete at interface of construction joints by abrasive blasting, hydroblasting, or using surface retardants and water jets to expose aggregate and remove accumulated concrete on projecting rebar immediately subsequent to form stripping, unless otherwise approved by Engineer. Immediately before placing fresh concrete, thoroughly clean

existing contact surface using stiff brush or other tools and stream of pressurized water. Surface shall be clean and wet, and free from pools of water at time of placing fresh concrete.

2. Remove laitance, waste mortar, and other substances that may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placing or where dirt or other bond reducing contaminants are on surface, perform additional light abrasive blasting or hydroblasting to remove laitance and all bond-reducing materials just prior to concrete placement.
3. Provide over contact surface of concrete a six-inch layer of Construction Joint Grout as specified in Section 03 6000, Grouting. Place fresh concrete before grout has attained its initial set. Placement of grout may be omitted if concrete mix has slump increased to at least six inches by addition of high range water reducer.

D. Vertical Joints:
1. Apply roughener to the form in thin, even film by brush, spray, or roller in accordance with manufacturer's instructions. After roughener is dry, concrete may be placed.
2. When concrete has been placed, remove joint surface forms as early as necessary to allow for removal of surface retarded concrete. Forms covering member surfaces shall remain in place as required under Section 03 1100, Concrete Forming. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by Engineer. Alternately, surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. Outer one-inch of each side of joint face shall be masked and protected from blasting to avoid damaging member surface.

E. Satisfactory Surface:
1. Roughen concrete surface so that amplitude between high and low point on any 2-inch square is at least 1/4 inch.
2. Remove all laitance, waste mortar or other substance, which may prevent complete adhesion.
3. Expose clean coarse aggregate.
4. Do not undercut edges of coarse aggregate particles.
5. After roughening, wash and rinse with potable water.
6. Continue rinsing as long as there is any trace of cloudiness of the rinse water.
7. Where the rinsing occurs more than 2 days prior to placing the next lift or where the work in the area subsequent to the cleaning causes dirt or debris to be deposited on the surface, the surface shall be rinsed again as the last operation prior to placing the next lift.

3.3 EXPANSION JOINTS

A. Comply with requirements of ACI 301 and this Section.

B. Locate and install expansion joints as shown and indicated in the Contract Documents. Install joint filler in accordance with manufacturer's instructions. Install sealants as specified in this Section.

3.4 CONTROL JOINTS

A. Provide control joints in non-water bearing slabs on grade as shown or indicated on the Drawings. Where control joints are not shown or indicated on the Drawings, space control joints at 24 to 36 times thickness of slab in both directions. Locate control joints only at places approved by Engineer.

B. A groove, with depth of at least 25 percent of the member thickness, shall be tooled, formed, or saw-cut in concrete. Groove shall be filled with joint sealant material in accordance with Section 07 9200, Joint Sealants.

C. Where control joint is formed by sawcutting, make sawcut in presence of Engineer immediately after concrete has set sufficiently to support the saw and be cut without damage to concrete. Keep concrete continually moist during cutting. Joints shall be approximately 1/8-inch wide.

D. Control joints may be formed with tool or by inserting joint forming strip. After concrete has achieved design strength, remove upper portion of joint forming strip and fill void with sealant.

3.5 ISOLATION JOINTS

A. Provide isolation joint where sidewalk or other slab on grade abuts a concrete structure and slab on grade is not shown doweled into that structure. Form isolation joint by 1/2-inch joint filler with upper 1/2-inch of joint filled with sealant.

3.6 WATERSTOPS

A. General:
1. Comply with ACI 301 and this Section. Make joints in accordance with manufacturer's instructions.
2. Provide PVC waterstops, except where otherwise shown or indicated on the Drawings.
3. Provide waterstops in all joints where concrete construction is below grade or intended to retain liquid. Install waterstop to the higher of: at least 12 inches above grade, or 12 inches above overflow liquid level in tanks.
4. Waterstops shall be fully continuous for extent of joint and with waterstops in intersecting joints. Maintain waterstop continuity at transitions between waterstops in joints at different levels and orientations.
5. In vertical joints in walls that are free at the top, waterstops shall extend no closer than six inches from top of wall.
6. In placing concrete around horizontal waterstops, with waterstop flat face in horizontal plane, work the concrete under waterstops by hand to avoid forming air and rock pockets.

B. Polyvinyl Chloride Waterstop:
1. Waterstops shall be positively held from displacement during concrete placing. Tie waterstops to reinforcement or other rigid supports at maximum spacing of 18 inches so that waterstop is securely and rigidly supported in proper position during concrete placing. Continuously inspect waterstops during concrete placing to ensure proper positioning.
2. Perform splicing in waterstops by heat sealing adjacent waterstop sections in accordance with manufacturer's printed recommendations. The following is required:
   a. Material shall not be damaged by heat sealing.
   b. Splices shall have tensile strength of not less than 60 percent of unspliced material's tensile strength.
   c. Maintain the continuity of waterstop ribs and of its tubular center axis.
3. Only butt-type joints of ends of two identical waterstop sections shall be made while material is in forms.
4. Prefabricated PVC Waterstop Joint:
   a. Joints with waterstops involving more than two ends to be jointed together, and joints that involve an angle cut, alignment change, or joining of two dissimilar

waterstop sections, shall be prefabricated by Contractor or manufacturer prior to placing in the forms.

b. Prefabricated joints shall have minimum of 2.0 feet of waterstop material beyond joint in each direction.

c. Install prefabricated joint assembly in the forms and butt-weld each two-foot end to a straight-run portion of waterstop in place in the forms.

5. Where centerbulb waterstop intersects and is jointed with non-centerbulb waterstop, seal end of centerbulb using additional PVC material as required.
6. Symmetrical halves of waterstops shall be equally divided between concrete placements at joints and centered within joint width, unless shown or indicated otherwise in the Contract Documents. Place centerbulb waterstops in expansion joints so that centerbulb is centered on joint filler material.
7. When waterstop is installed in the forms or embedded in first concrete placement and waterstop remains exposed to atmosphere for more than four days, implement suitable precautions to shade and protect exposed waterstop from direct rays of sun during entire exposure, until exposed portion of waterstop is embedded in concrete.
8. Protect waterstop placed in joints intended for future concrete placement from direct rays of the sun by temporary means until permanent cover is installed, so that waterstop is not exposed to direct rays of the sun for more than four days total.

C. Hydrophilic Rubber Waterstop and Sealant:

1. Where a hydrophilic rubber waterstop or sealant is required in accordance with the Contract Documents, or where approved by Engineer, install waterstop or sealant in accordance with manufacturer's instructions and recommendations; except, as modified in the Contract Documents.
2. When requested by Engineer, provide manufacturer's technical assistance at the Site.
3. Locate waterstop or sealant as near as possible to center of joint. Waterstop or sealant shall be continuous around entire joint. Minimum distance from edge of waterstop to face of the member shall be three inches.
4. Where hydrophilic rubber waterstop is used in combination with PVC waterstop, hydrophilic rubber waterstop shall overlap PVC waterstop for minimum of six inches. Fill contact surface between hydrophilic rubber waterstop and PVC waterstop with hydrophilic sealant.
5. Where wet curing methods are used, apply hydrophilic rubber waterstop and sealant after curing water is removed and just prior to closing up of the forms for concrete placement. Protect hydrophilic rubber waterstop and sealant from direct rays of sun and from becoming wet prior to concrete placement. If material becomes wet and expands, allow material to dry until material has returned to original cross sectional dimensions before placing concrete.
6. Install hydrophilic rubber waterstop in bed of hydrophilic sealant, before skinning and curing begins, so that irregularities in concrete surface are completely filled and waterstop is bonded to sealant. After sealant has cured, install concrete nails, with washers of a diameter equal to waterstop width, to secure waterstop to concrete at maximum spacing of 1.5 feet.
7. Prior to installing hydrophilic sealant, wire brush or sandblast the concrete surface to remove laitance and other materials that may interfere with bonding. Metal and PVC surfaces to receive sealant shall be cleaned of paint and any material that may interfere with bond. When sealant alone is shown or indicated in the Contract Documents, place sealant placed in built-up bead which has a triangular cross section with each side of triangle at least 3/4-inch long, unless otherwise indicated in the Contract Documents. Do not place concrete until sealant has cured as recommended by sealant manufacturer.

3.7 BONDING AGENT

A. Use epoxy bonding agent for bonding of fresh concrete to concrete that has been in place for at least 60 days, and for bonding to existing concrete.

B. Use epoxy-cement bonding agent for the following:
   1. Bonding toppings and concrete fill to concrete that has been in place for at least 60 days, and for bonding to existing concrete.
   2. For locations where bonding agent is required and concrete cannot be placed within open time period of epoxy bonding agent.
   3. Bonding of horizontal construction joints where joints are required in accordance with the Drawings or approved by Engineer for foundation mats that are five feet thick or greater.

C. Use cement-water slurry as bonding agent for toppings and concrete fill to new concrete. Cement water slurry shall be worked into surface with stiff bristle broom and place the concrete before cement-water slurry dries.

D. Handle and store bonding agent in accordance with manufacturer's printed instructions and safety precautions.

E. Mix bonding agent in accordance with manufacturer's instructions.

F. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with bonding agent not less than 1/16-inch thick. Place fresh concrete while bonding agent is still tacky (within its open time), without removing in-place bonding agent coat, and as directed by manufacturer.

END OF SECTION 03 1500

SECTION 03 2000

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete reinforcing.
2. Extent of concrete reinforcing is shown and indicated in the Contract Documents.
3. Work includes fabrication and placement of reinforcing including bars, ties, and supports, and welded wire fabric for concrete, encasements, and fireproofing.

B. Related Sections:
1. Section 03 1500, Concrete Accessories.
2. Section 04 0505, Unit Masonry Construction.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. ACI 315, Details and Detailing of Concrete Reinforcement.
2. ACI 318, Building Code Requirements for Structural Concrete.
3. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
4. ANSI/AWS D1.4, Structural Welding Code - Reinforcing Steel.
5. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
6. ASTM A185, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
7. ASTM A615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
8. ASTM A706, Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
9. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
10. Concrete Reinforcing Steel Institute (CRSI), CRSI 1MSP, Manual of Standard Practice.
11. ICC Evaluation Service (ES) AC 308, Acceptance Criteria for Post-Installed Anchors in Concrete Elements.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Testing Laboratory: Shall meet requirements of ASTM E329 and shall have experience in the testing welded splices of reinforcing steel and tension testing of reinforcing bars set in adhesive in hardened concrete.
2. Installer of Adhesive Dowels: Installation shall be performed by personnel certified under an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchors Installer Certification Program, or equivalent. Description of equivalent programs shall be submitted for Engineer's approval and acceptance by the building official having jurisdiction.

B. Certifications:
1. Weld Procedures: For types of splices and grades of reinforcing used in the Work, weld procedures for welded reinforcing steel splices shall be certified in accordance with ANSI/AWS D1.4.
2. Welders: For types of splices and grades of reinforcing used in the Work, welders shall be certified for welding reinforcing steel splices in accordance with ANSI/AWS D1.4.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI 315, Parts A and B.
b. For walls, show elevations at minimum scale of 1/4-inch to one foot.
1) Elevations shall show all openings and reference details that identify additional reinforcing required around each opening.
2) Elevations shall denote each wall intersection and reference a detail that identifies additional reinforcing required at wall intersection. As an alternate to providing separate details for each wall intersection, provide overall plan detailing only the additional wall intersection reinforcing for each wall intersection.
c. For slabs and mats, show top and bottom reinforcing on separate plan views.
1) Plans shall show all openings and shall reference details that identify additional reinforcing around each opening.
d. Show bar schedules, stirrup spacing, diagrams of bent bars, location of bar splices, length of lap splices, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing unless otherwise noted.
e. Provide plans and elevations detailing location, spacing, and lengths of masonry wall dowels, where masonry is required. Coordinate location of dowels with masonry openings and with standard modular spacing. Submit masonry wall dowels with reinforcing submittal for element into which masonry dowel will be embedded. Coordinate with Section 04 0505, Unit Masonry Construction.
f. Splices shall be kept to a minimum. Avoid, when possible, splices in regions of maximum tensile stresses.
g. Drawings detailing location of all construction and expansion joints, as required under Section 03 1500, Concrete Accessories, shall be submitted and approved before Shop Drawings for reinforcing are submitted.
h. Drawings detailing location, spacing, edge distance, and embedment depth of adhesive dowels. Adhesive system shall be submitted and approved before Shop Drawings with adhesive dowels are submitted.
2. Product Data:
a. Manufacturer's product data for adhesive, if not submitted under other Sections.
b. Adhesive manufacturer's test data and ICC ES report to verify specified capacity of adhesive dowels.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Steel manufacturer's certificates of mill analysis, tensile, and bend tests for reinforcing steel.
b. Certification of welders and weld procedures for splices.

c. Adhesive manufacturer's certification verifying that installer is qualified and using proper installation procedures.

2. Manufacturer's Instructions:
   a. Installation instructions for adhesive systems.
3. Special Procedure Submittals; Description of reinforcing weld locations and weld procedures, only when allowed by Engineer.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.

B. Store concrete reinforcing products to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: Shall be deformed in accordance with ASTM A615, and as follows:
   1. Provide Grade 60 for all bars, unless indicated otherwise.
   2. At beams and columns forming frames and wall boundary elements, where shown on the Drawings, provide ASTM A706 or ASTM A615, Grade 60, with tested actual maximum yield stress of 78,000 psi and ratio of actual tested tensile strength to tested yield strength not less than 1.25.

B. Mechanical Couplers: Reinforcement bars may be spliced with mechanical connection. Connection shall be full mechanical connection that shall develop in tension or compression, as required, at least 125 percent of specified yield strength (fy) of bar in accordance with ACI 318 and ACI 350. Where splices at the face of wall are shown or approved by Engineer, form saver-type mechanical couplers may be used. Form-saver couplers shall have integral plates designed to positively connect coupler to formwork.

C. Steel Wire: Shall be in accordance with ASTM A82.

D. Welded Smooth Wire Fabric: Shall be in accordance with ASTM A185.
   1. Furnish in flat sheets, not rolls.

E. Column Spirals: Hot-rolled rods for spirals, conforming to ASTM A615.

F. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in place.
   1. Use wire bar type supports complying with CRSI 1 MSP recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use precast concrete blocks, four inches square in plan, with embedded tie wire as specified by CRSI 1 MSP. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.
   3. For concrete surfaces where legs of supports are in contact with forms, provide supports complying with CRSI 1 MSP as follows:

a. At formed surfaces in contact with soil, weather, or liquid, or located above liquid, supports shall be CRSI Class 1 for maximum protection. Plastic coating on legs shall extend at least 0.5-inch upward from form surface.
b. At interior dry surfaces (not located above liquid), supports shall be either Class 1 or Class 2 for moderate protection.

G. Adhesive Dowels:
1. Products and Manufacturers:
a. HIT-RE 500-V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
b. SET-XP Adhesive anchoring system, by Simpson Strong-Tie Company, Inc.
c. Or Equal.
2. Dowels:
a. Dowel reinforcing bars shall be deformed in accordance with ASTM A615, Grade 60.
3. Adhesive:
a. Adhesive system shall use two-component adhesive mix.
b. Adhesives shall have a current evaluation report by ICC Evaluation Service for use with steel reinforcing bars in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308, which incorporates the requirements of ACI 355.4.
c. Adhesives shall have minimum bond strength and minimum design bond strength in accordance with Table 03 20 00-A.

TABLE 03 20 00-A: ADHESIVE BOND STRENGTH [1,2]

Bond Strength (psi)		
Dowel Size	**Uncracked Concrete**	**Cracked Concrete**
#4	1500	1080
#5	1460	1090
#6	1415	1015
#7	1370	835
#8	1330	760
#9	1560	850
#10	1240	475

Table Notes:
1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 130 degrees F and maximum long term concrete temperature of 110 degrees F.

2.2 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI 1 MSP. In case of fabricating errors, do not re-bend or straighten reinforcing in manner that injures or weakens material.

B. Unacceptable Materials: Reinforcing with one or more of the following defects is not allowed:
1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
2. Bends or kinks not shown on approved Shop Drawings.

3. Bars that do not meet or exceed their ASTM specification requirements when hand-wire-brushed, with respect to cross section, nominal weight, or average height of deformations.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which concrete reinforcing is to be placed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable recommendations of Laws and Regulations, applicable standards, and CRSI 1 MSP for details and methods of reinforcing placement and supports, and as required below.

B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required. The use of dropped bars will not be allowed. Reinforcing bars intended as main reinforcing and temperature reinforcing shall remain in their intended plane.
   1. Place reinforcing to obtain minimum concrete coverages specified in ACI 318, AC I 350, and the Contract Documents. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Prior to placing concrete, using surveyor's level or string line, demonstrate to Engineer that specified cover of reinforcing has been attained.
   3. Do not secure reinforcing steel to forms with wire, nails, or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.
   4. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than 1-bar diameter, or enough to exceed the inspection tolerances, the resulting arrangement of bars shall be subject to review and acceptance by Engineer.
   5. Conduit placement within slabs/walls shall follow the location and minimum clearance requirements shown on the Contract Drawings.

D. Allowable Placing Tolerances: Comply with ACI 318, Chapter 7 - Details of Reinforcement, and ACI 350, Chapter 7 - Details of Reinforcement, except as specified in this Section:
   1. Concrete surfaces in contact with liquid shall have minimum of two inches of concrete over reinforcing steel.

E. Provide sufficient number of supports of strength required to carry reinforcing. Do not place reinforcing bars more than two inches beyond last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Lap Splices:

1. Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars as shown on the Drawings.

G. Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with 16-gage wire. Do not make end laps midway between supporting beams, or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.

H. Mechanical Couplers:
1. Mechanical butt splices shall be in accordance with recommendations of mechanical splicing device manufacturer. Butt splices shall develop 125 percent of specified minimum yield tensile strength of spliced bars or of smaller bar in transition splices. Bars shall be flame-dried before butt splicing. Provide adequate jigs and clamps or other devices to support, align, and hold longitudinal centerline of bars being butt spliced in straight line.

I. Welded Splices:
1. When field welding of reinforcing is required on the Drawings or allowed by Engineer in writing, welding of reinforcing bars shall conform to ANSI/AWS D1.4. Preheating and rate of cooling requirements shall be based on bar steel chemistry and ANSI/AWS D1.4. Welded splices shall be sized and constructed to transfer minimum of 125 percent of specified minimum yield tensile strength of spliced bars or of smaller bar in transition splices. Unless otherwise allowed by ENGINEER in writing, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.
2. Welding of wire to wire, and of wire or welded wire fabric to reinforcing bars or structural steels, shall conform to applicable provisions of ANSI/AWS D1.4 and Engineer's requirements for the particular application.
3. After completing welding on coated reinforcing bars, repair coating damage as specified in this Section. Welds and steel splice members, when used to splice bars, shall be coated with same material used for repair of coating damage.

J. Adhesive Dowels:
1. Comply with manufacturer's written installation instructions and requirements of this Section.
2. Drill holes to adhesive system manufacturer's recommended drill bit diameter and to specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances indicated in ANSI B212.15. Core-drilled holes shall not be permitted.
3. Before setting adhesive dowel, hole shall be made free of dust and debris by method recommended by adhesive system manufacturer. Brush the hole with adhesive system manufacturer-approved brush and blow hole clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
4. Before injecting adhesive, obtain Engineer's concurrence that hole is dry and free of oil and other contaminants.
5. Prior to injecting adhesive into the drilled hole, dispense to an appropriate location for waste an initial amount of adhesive from the mixing nozzle until adhesive is a uniform color, indicating that product is properly mixed.
6. Inject adhesive into hole through injection system-mixing nozzle and extension tubes (as required) placed to bottom of hole. Withdraw nozzle's discharge end as adhesive is placed

while keeping nozzle immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placing.

7. Twist dowel during insertion into partially-filled hole to ensure full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining or adjacent Work that could impose or impart load on the dowels. Do not begin adjoining or adjacent Work until dowels are successfully tested or when approved by Engineer.
9. Limitations:
    a. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with requirements of adhesive systems manufacturer during installation and adhesive system curing.
    b. Oversized Holes: Advise Engineer immediately if size of drilled hole is larger than recommended by adhesive system manufacturer. Cost of corrective measures, including but not limited to redesign of dowels due to decreased capacities, shall be paid by Contractor.

3.3 FIELD QUALITY CONTROL

A. Site Inspections and Tests:
    1. General:
        a. Do not place concrete until reinforcing is inspected, and permission for placing concrete is granted by Engineer. Concrete placed in violation of this provision will be rejected.
        b. Do not close up formwork for walls and other vertical members until reinforcing is inspected, and permission for placing concrete is granted by Engineer. Concrete placed in violation of this provision will be rejected.
        c. Correct defective Work by removing and replacing or correcting, as required by Engineer.
        d. Contractor shall pay cost of corrections and subsequent testing required to confirm integrity of post-installed anchors.
        e. Testing laboratory shall submit test results to Contractor and Engineer within 24 hours of completion of test.
    2. Site Tests:
        a. Owner will employ testing laboratory to perform field quality testing of adhesive dowels at the Site.
            1) Testing shall comply with ASTM E488.
            2) Test at least ten percent of each type of adhesive dowel. If one or more dowels fail the test, Contractor shall pay cost to test all dowels of same diameter and type installed on the same day as the failed dowel.
            3) Test dowels to 60 percent of specified yield strength. Engineer will direct which dowels are to be tested.
            4) Apply test loads with hydraulic ram.
            5) Displacement of dowels shall not exceed D/10, where D is nominal diameter of dowel.
    3. Inspection of Welded Splices: Owner will employ testing laboratory to perform field quality control testing of welded splices. All welded splices shall be visually inspected. Radiographically test minimum of five percent of butt splice welds. Repair defective welds so that welds are completely sound.

B. Manufacturer's Services:

1. Provide qualified adhesive manufacturer's representative at the Site during initial installation of adhesive dowel systems to train installing personnel in proper selection and installation procedures. Manufacturer's representative shall observe to verify that installer demonstrates proper installation procedures for adhesive dowels and adhesive material. Each installer shall be certified in writing by manufacturer as qualified to install adhesive anchors.

END OF SECTION 03 2000

SECTION 03 3000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install cast-in-place concrete.
   2. Concrete shall be in accordance with requirements of ACI 301 and ACI 350.5 unless otherwise specified.
   3. The Work includes providing concrete consisting of Portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured. The Work also includes:
      a. Providing openings in concrete to accommodate the Work under this and other Sections, and building into the concrete all items such as sleeves, frames, anchorage devices, inserts, and all other items to be embedded in concrete Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.

C. Classifications of Concrete:
   1. Class “A” concrete includes the following:
      a. All concrete, unless otherwise shown or indicated.
   2. Class “AF” concrete may be used in lieu of Class “A” concrete for the following:
      a. Walls and foundations thicker than 16 inches.
   3. Class “B” concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following, unless otherwise shown or indicated:
      a. Concrete fill within structures.
      b. Duct banks.
      c. Unreinforced encasements.
      d. Curbs and gutters.
      e. Sidewalks.
      f. Thrust blocks.
   4. Class “D” concrete shall be unreinforced and used where required as concrete fill under foundations, filling abandoned piping, and where “lean concrete” or “mudmat” is shown or indicated in the Contract Documents.
   5. Class “SC” self-consolidating concrete shall be used at CONTRACTOR’s discretion.
   6. For the following locations, Class "A" and/or "AF" shall include the Crystalline Waterproofing Admixture and shall be designated Class "AW" and "AFW".
      a. Basement foundation slab (top of slab elevation 746.50).
      b. Break Tank perimeter walls from elevation 772.83 to elevation 746.50.

D. Related Sections:
   1. Section 03 1500, Concrete Accessories.
   2. Section 03 2000, Concrete Reinforcing.
   3. Section 03 6000, Grouting.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. AASHTO M 182, Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Materials.
2. AASHTO T318, Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
3. ACI 117, Specifications for Tolerances for Concrete Construction and Materials and Commentary.
4. ACI 301, Specifications for Structural Concrete.
5. ACI 305.1, Specification for Hot Weather Concreting.
6. ACI 306.1, Cold Weather Concreting.
7. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
8. ACI 350/350R, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
9. ACI 350.5, Specifications for Environmental Concrete Structures.
10. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
11. ASTM C33, Specification for Concrete Aggregates.
12. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Con-crete Specimens.
13. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
14. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
15. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
16. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
17. ASTM C143/C143M, Test Method for Slump of Hydraulic- Cement Concrete.
18. ASTM C150, Specification for Portland Cement.
19. ASTM C157/C157M, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
20. ASTM C171, Specification for Sheet Materials for Curing Concrete.
21. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
22. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
23. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
24. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
26. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
27. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
28. ASTM C989, Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
29. ASTM C1017, Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
30. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
31. ASTM C1077, Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

32. ASTM C1610, Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique.
33. ASTM C1611, Test Method for Slump Flow of Self-Consolidating Concrete.
34. ASTM C1621, Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring
35. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Caused by Exposure to Heat and Moisture.
36. ASTM D3574, Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams.
37. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials
38. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, and Special Inspection.
39. ASTM E1643, Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
40. ASTM E1745, Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
41. NSF/ANSI 61, Drinking Water System Components - Health Effects.
42. NRMCA, National Ready Mixed Concrete Association.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Concrete Testing Laboratory:
      a. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. Employ different laboratories for design of concrete mixes and field testing.
         1) Testing agency shall be in accordance with ASTM E329 and ASTM C1077.
         2) Testing laboratory shall have been inspected and passed within previous two years by Cement and Concrete Reference Laboratory (CCRL) of NIST for: testing concrete aggregates, and for preparing and testing concrete trial batches with or without admixtures. Testing laboratory shall provide documentation indicating how deficiencies, if any, in most recent CCRL inspection report were corrected.
         3) Selection of testing laboratory is subject to Owner's acceptance.
         4) Submit written description of proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities, and equipment, and other information requested by Engineer.
   2. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
   3. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
   4. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
   5. Water Reducing Admixture Manufacturer:
      a. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. Submit copy of manufacturer's quality assurance handbook to document program existence.
      b. Manufacturer shall maintain a concrete testing laboratory approved by CCRL at NIST.

c. Manufacturer shall be capable of providing services of qualified field service representatives at the Site.

B. Laboratory Trial Batch:
1. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
2. For classes of concrete that require air-entrainment, test the trial batch at highest percentage of air (plus 1.5 percent) allowed for that class of concrete.
3. Perform the following testing on each trial batch:
   a. Aggregate gradation for fine and coarse aggregates.
   b. Fly ash testing to verify meeting specified properties, unless fly ash Supplier submits certification by an independent testing laboratory.
   c. Slump.
   d. Where mix is designed to be self-consolidating concrete: slump flow, passing ability, visual stability index, and static segregation.
   e. Air content.
   f. Compressive strength based on three cylinders each tested at seven days and at 28 days.
   g. Shrinkage test in accordance with this Section, for Class "A" concrete, Class "AF" concrete, and Class "SC" concrete.
4. Submit for each trial batch the following information:
   a. Project identification name and number (if applicable).
   b. Date of test report.
   c. Complete identification of aggregate source of supply.
   d. Tests of aggregates for compliance with the Contract Documents.
   e. Scale weight of each aggregate.
   f. Absorbed water in each aggregate.
   g. Brand, type, and composition of cementitious materials.
   h. Brand, type, and amount of each admixture.
   i. Amounts of water used in trial mixes.
   j. Proportions of each material per cubic yard.
   k. Gross weight and yield per cubic yard of trial mixtures.
   l. Measured slump. Where mix is self-consolidating concrete: measured slump flow, time to reach 20-inch diameter, passing ability, visual stability index, and static segregation.
   m. Measured air content.
   n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28 day test, and for each design mix.
   o. Shrinkage test results where required and as specified in this Section. Report results and averages for original length and at zero, seven, 14, 21, and 28 days of drying.

C. Shrinkage Test:
1. Perform drying shrinkage tests for trial batch as specified in this Section.
2. Drying shrinkage specimens shall be four-inch by four-inch by 11-inch prisms with effective gage length of ten inches; fabricated, cured, dried, and measured in accordance with ASTM C157 modified as follows: remove specimens from molds at an age of 23 hours, plus-or-minus one hour, after trial batching; shall be placed immediately in water at 70 degrees F plus-or-minus three degrees F for at least 30 minutes; and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F plus-or-minus three degrees F. Measurement to determine expansion expressed as percentage of original length shall be made at age of seven days.

Length at age of seven days shall be base length for drying shrinkage calculations (zero days drying age). Immediately afterward store specimens in humidity-controlled room maintained at 73 degrees F plus-or-minus three degrees F, and 50 percent (plus-or-minus four percent) relative humidity for remainder of test. Obtain measurements to determine shrinkage expressed as percentage of base length and report measurements separately for seven, 14, 21, and 28 days of drying after seven days of moist curing.

3. Determine drying shrinkage deformation of each specimen as the difference between base length (at zero days drying age) and length after drying at each test age. Determine average drying shrinkage deformation of specimens to nearest 0.0001-inch at each test age. If drying shrinkage of a specimen departs from average of that test age by more than 0.0004-inch, results obtained from that specimen shall be disregarded. Report results of shrinkage test to nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from same concrete used for preparing drying shrinkage specimens. Tests shall be considered part of normal compression tests for the Work. Allowable shrinkage limitations shall be as specified in Part 2 of this Section.

D. Component Supply and Compatibility:
   1. Provide a certificate of compatibility for all admixture materials.

E. Concrete Coordination Conference:
   1. Conduct concrete coordination conference to review detailed requirements of Contractor's proposed concrete design mixes, to discuss procedures for producing proper concrete construction, and to clarify roles of the parties involved. Contractor shall organize and schedule the conference, and prepare and distribute to all parties attending conference minutes of the conference.
   2. Conduct concrete coordination conference no later than 14 days after the date the Contract Times commence running. Conference shall be held at mutually agreed upon date and time; conference shall be held at the Site unless otherwise mutually agreed upon. Notify all parties to attend concrete coordination conference not less than five days prior to scheduled date of conference.
   3. Additional structure specific concrete construction conferences shall be held as required by the Engineer.
   4. All parties involved in the concrete Work shall attend concrete coordination conference including, but not limited to, the following:
      a. Contractor.
      b. Field testing services representative.
      c. Concrete Subcontractor (if any).
      d. Reinforcing steel Subcontractor (if any) and reinforcing steel Supplier and detailer.
      e. Concrete Supplier.
      f. Admixture manufacturer's representative.
      g. Engineer.
      h. Concrete special inspector.
      i. Resident Project Representative (if any).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Mix Design:
         1) List of concrete materials and proportions for the proposed concrete mix designs. Include data sheets, test results, certifications, and mill reports to

qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until this submittal is approved by Engineer.

2) Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.

b. Concrete Supply:

1) Ready-mixed Concrete: Submit the following information.

a) NRMCA plant certification.

b) Physical capacity of mixing plant.

c) Trucking facilities available.

d) Estimated average amount of the specified concrete that can be produced and delivered to the Site during a normal, eight-hour day, excluding output to other customers.

2. Product Data:

a. Manufacturers' specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.

3. Samples:

a. Submit Samples of materials as specified and as requested by Engineer. Include with each Sample names of product and Supplier, and description.

4. Curing and Protection Plans:

a. Submit detailed plan for curing concrete in water retaining and non-water retaining structures.

b. Submit detailed plan for curing and protection of concrete placed and cured in cold weather.

c. Submit detailed plan for curing and protection of concrete placed and cured in ambient temperatures over 80 degrees F.

B. Informational Submittals: Submit the following:

1. Certifications:

a. Notarized certification of conformance to reference standards used in this Section, when required by Engineer.

b. Flatwork finisher certification.

2. Delivery Tickets: Copies of all delivery tickets for each load of concrete delivered to or mixed at the Site submitted prior to unloading. Each delivery tickets shall contain the information in accordance with ASTM C94 requirements of sections 14.2.1 through 14.2.10 along with project identification name and number (if any), date, mix type, mix time, quantity and amount of water initially withheld and introduced on site.

3. Minutes of the Concrete Coordination Conference and other subsequent structure specific concrete construction conferences.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Transportation, Delivery, and Handling:

1. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.

2. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.

B. Storage:

1. For storage, provide bins or platforms with hard, clean surfaces.

PART 2 - PRODUCTS

2.1 GENERAL

A. All cementitious materials, admixtures, curing compounds, and other industrial-produced materials used in concrete, or for curing or repairing of concrete, that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

2.2 CEMENTITIOUS MATERIALS

A. Cement:
   1. Portland cement shall be Type II(MH) ASTM C150. Type I or Type II may be used in lieu of Type II(MH) when approved by Engineer.
   2. Portland cement shall be produced by one manufacturer's facility. Cement from other facilities of the manufacturer shall be tested for similarity of properties. Tested cement with different properties or alternate cement sources of other manufacturers may be used provided that mix design has been approved and acceptable trial batch verifying performance has been made.
   3. Do not use cement that has deteriorated because of improper storage or handling.

B. Fly Ash:
   1. Fly Ash, when used, shall conform to the requirements of ASTM C618 Class F, except as follows:
      a. The loss on ignition shall be a maximum of four percent.
      b. The maximum percent of sulfur trioxide (SO3) shall be 4.0.
   2. Fly ash shall be considered to be a cementitious material.
   3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.

C. Slag Cement:
   1. Slag cement, when used, shall conform to ASTM C989, Grade 120.
   2. Slag cement shall be considered a cementitious material.
   3. Perform laboratory tests on trial batches to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.

D. For all classes of concrete, when Type II(MH) Cement is used, fly ash or slag cement may be used within the following percentages by weight. When Type II Cement is used, fly ash or slag cement shall be used within the following percentages by weight. When Type I Cement is used, in lieu of Type II(MH) Cement, fly ash or slag cement shall be used such that total tricalcium aluminate content (C3A) of the resulting cementitious material is not greater than eight percent. Class "SC" concrete shall contain fly ash or slag cement regardless of cement type used.
   1. When fly ash is used, material shall have minimum of 20 percent and maximum of 25 percent of total weight of cementitious material.
   2. When slag cement is used, material shall have minimum of 40 percent and maximum of 50 percent of total weight of cementitious material.

2.3 AGGREGATES

A. General:
   1. Aggregates shall conform to ASTM C33, Class Designation 4S, and as specified in this Section.

2. Do not use aggregates containing soluble salts or other substances, such as iron sulfides, pyrite, marcasite, ochre, or other materials, that can cause stains on exposed concrete surfaces.

B. Fine Aggregate:
   1. Provide clean, sharp, natural sand free of loam, clay, lumps, and other deleterious substances.
   2. Dune sand, bank run sand, and manufactured sand are unacceptable.

C. Coarse Aggregate:
   1. Provide clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
      a. Crushed stone, processed from natural rock or stone.
      b. Washed gravel, either natural or crushed. Slag, pit gravel, and bank run gravel are unacceptable.

2.4 WATER

A. Water used in producing and curing concrete shall be clean and free of injurious quantities of oils, acids, alkalis, organic materials, and other substances that may be deleterious to concrete and steel.

2.5 CONCRETE ADMIXTURES

A. Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Admixtures shall not contain thiocyanates, shall not contain more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise approved by Engineer.

B. Air entraining admixture shall meet the requirements of ASTM C260.

C. Water-Reducing Admixture: ASTM C494, Type A or D.
   1. Proportion Class "A", Class "AF", Class "AS", and Class "B" concrete with non-air entraining, water-reducing, aqueous solution of modified organic polymer. Admixture shall not contain lignin, nitrates, or chlorides added during manufacturing.

D. High Range Water-Reducing Admixture (HRWR): ASTM C494, Type F or G.
   1. Use high range water-reducing admixture in the concrete classifications so specified or indicated. Use of HRWR admixture is allowed at Contractor's option in all other classifications of concrete. Specific admixture formulation shall be as recommended by admixture manufacturer for Project conditions. HRWR admixture used for Class "SC" concrete shall be polycarboxylate-based.
   2. Products:
      a. Plastol Series by The Euclid Chemical Company.
      b. Glenium Series by BASF.
      c. Or equal.

E. Plasticizing Admixtures: ASTM C1017, Type I or Type II

1. Use plasticizing admixture as an alternate to high range water-reducing admixture. Specific admixture formulation shall be as recommended by admixture manufacturer for Project conditions.

F. Viscosity Modifying Admixture:
   1. Where necessary to control segregation of self-consolidating concrete, a viscosity modifying admixture shall be combined with a high range water reducing admixture either separately or in a combined admixture. Viscosity modifying and high range water reducing admixtures shall be from the same manufacturer and of the recommended types and dosages needed to produce the required concrete flowability and passing ability without segregation.

G. Set Control Admixtures: In accordance with ASTM C494. Use the following as required:
   1. Type B, Retarding.
   2. Type C, Accelerating.
   3. Type D, Water reducing and Retarding.
   4. Type E, Water reducing and Accelerating.
   5. Type F, Water-reducing, high range admixtures.
   6. Type G, Water-reducing, high range, and retarding admixtures.

H. Calcium Chloride: Do not use calcium chloride.

I. Shrinkage Reducing Admixture:
   1. Shrinkage reducing admixture may be used in mix design when necessary to conform to specified shrinkage limitations, provided that specified strength requirements are complied with and there is no reduction in sulfate resistance in the concrete and no increase in concrete permeability.
   2. Products:
      a. Conex or Eucon SRA by The Euclid Chemical Company
      b. MasterLife SRA 20 by BASF Corporation.
      c. Sika Control 40 by Sika Corporation.
      d. Or equal.

J. Hydration Controlling Admixture:
   1. Where extended concrete delivery times are authorized by the Engineer, one of the following hydration controlling admixtures shall be used.
   2. Products:
      a. SikaTard 440, manufactured by Sika Corporation.
      b. Eucon DS, manufactured by the Euclid Chemical Company.
      c. MasterSet DELVO, manufactured by BASF Corporation.
      d. Or equal

K. Crystalline Waterproofing Admixture:
   1. Use a cementitious, capillary waterproofing admixture which, when added at the dosage rate of 1% by weight of cement, will permanently fix a non-soluble crystalline structure throughout the capillary voids of the concrete and cause the concrete to become sealed against the penetration of liquids.
   2. Product and Manufacturer: Provide one of the following:
      a. Xypex Admix C-500, as manufactured by Xypex Chemical Corporation.
      b. Or equal.

2.6 PROPORTIONING AND DESIGN OF MIXES

A. Prepare concrete design mixes in accordance with Table 03 3000-A:

TABLE 03 3000-A
CONCRETE DESIGN MIX CRITERIA

Concrete Class	Coarse Aggregate[1]		Minimum	Max. W/CM[4]	Slump[2]	Air (%)	Min. Comp Strength[3] (psi)
	Size A	Size B	Cementitious (lbs/cu yd)				
Class "A" Class "AW"	No. 57	No. 8	535	0.42	4" max.	6 +/- 1.5	4,500
Class "AF" Class "AFW"	No. 467	No. 8	517	0.42	4" max.	5 +/- 1.5	4,500
Class "B"	No. 57 or No. 67		517	0.50	4" max.	6 +/- 1.5	3,000
Class "SC"	No. 57	No. 8	535	0.40	Slump flow[7]	6 +/- 1.5	4,500
Class "D"	Any ASTM C33		No requirements				2,000

Notes Applicable to Table 03 3000-A:

1. Coarse aggregate size numbers refer to ASTM C33. Where Size A and B are designated in Table 03 30 00-A, it is intended that the smaller Size B aggregate is to be added, replacing a portion of the coarse or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with sand content not exceeding 41 percent of total aggregate. For Class "SC" concrete, sand content shall not exceed 43 percent of total aggregate and No. 8 aggregate shall comprise a minimum of 10 percent of total aggregate.
2. Slumps indicated are prior to addition of high range water reducing admixture or plasticizing admixture.
3. Mix designs shall be made for all but Class "D", which does not require trial batch, so that the compressive strength achieved for laboratory trial batches will not be less than 125 percent of specified design strength.
4. Quantity of water to be used in the determination of water-cementitious materials (W/CM) ratio shall include free water on aggregates in excess of SSD and water portion of admixtures.
5. Minimum cementitious content shall be adjusted in accordance with the requirements of ACI 350.5 and ACI 301 if smaller maximum coarse aggregate size is used.
6. Required air content listed shall be adjusted in accordance with the requirements of ACI 350.5 and ACI 301 for cycles of freezing and thawing if a different maximum coarse aggregate size is used.
7. Class "SC" concrete is self-consolidating concrete. Design mix to meet required plastic properties.

B. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, Site conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as approved by Engineer. Before using adjusted concrete mixes, laboratory test data and strength results shall be submitted to and approved by Engineer.

C. Admixtures:
   1. Use air-entraining admixture in concrete, unless otherwise shown or indicated. Add air-entraining admixture at admixture manufacturer's prescribed rate to produce concrete at point of placement having air content within prescribed limits.
   2. Use water-reducing or high-range water-reducing admixtures in all class "A", class "AF", class "AW", class "AFW", and class "SC" concrete.

3. Use amounts of admixtures recommended by admixture manufacturer for climatic conditions prevailing at the Site at time of placing. Adjust quantities and types of admixtures as required to maintain quality.

D. If adding water at the Site is desired, withhold water at the batch plant so that specified water-cement (or cementitious material) ratio is not exceeded. Addition of water shall be accordance with ASTM C94. After high-range water-reducing admixture is incorporated into the batch, addition of water is not allowed. Additional high-range water reducing admixture may be added at the Site.

E. Slump Limits with High-Range Water Reducer:
1. Slump shall not exceed three inches prior to adding high-range water reducer and shall not exceed nine inches, measured at point of placement, after adding high-range water reducer, except where the mix is designed as self-consolidating concrete.

F. Plastic Properties Required for Self-Consolidating Concrete:
1. Class "SC", self-consolidating concrete, shall have the following plastic properties.
   a. Slump flow, as determined by ASTM C1611, shall be 26 inches +/- 2 inches with a visual stability index of 0 or 1 and time to reach 20-inch diameter of 3.5 seconds +/- 1 second.
   b. Passing ability of no greater than 1.5-inch difference between slump flow and J-Ring flow as measured by ASTM C1621.
   c. Static segregation of less than 5 percent when tested per ASTM C1610.

G. Shrinkage Limitation:
1. Concrete shrinkage for specimens cast in laboratory from trial batch with total water of 30.2 gallons per cubic yard or less, as measured at 21-day drying age and at 28-day drying age shall not exceed 0.035 percent and 0.005 percent, respectively. For trial batch with total water of 32.7 gallons per cubic yard or greater respective limits shall not exceed 0.030 percent and 0.036 percent. Limits in between shall be linear interpolated. Use mix design for construction that complies with trial batch shrinkage requirements. Shrinkage limitations apply to Class "A" concrete and Class "AF" concrete. Shrinkage limits for Class "SC" concrete shall meet the above requirements with an increase is allowable shrinkage of 0.003 percent for each category.
2. Trial Batch Does Not Comply with Shrinkage Limitation:
   a. If trial batch results do not comply with shrinkage limitation specified in the Contract Documents, redesign the mix to reduce shrinkage.
   b. After mix has been repeatedly redesigned and Engineer is satisfied that all reasonable means to provide concrete mix that complies with shrinkage requirement have been exercised; and mix design still fails to comply with shrinkage limitation in the Contract Documents, Engineer reserves the right to accept the higher-shrinkage mix, provided that the quantity of shrinkage reinforcing in structures is increased.
   c. "Reasonable means" will be construed as reducing the total water content to a maximum of 27 gallons per cubic yard, having the large aggregate blended so that eight percent to 18 percent of combined aggregate is retained on each sieve, using an alternate aggregate source, using a shrinkage reducing admixture, and a combination of these means.
   d. Basis for shrinkage reinforcing increase will be proportional to amount that shrinkage value is over the specified shrinkage limitation and will be determined by

Engineer. The cost of providing additional shrinkage reinforcement will be paid by the Owner.

2.7 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents in accordance with Section 03 1500, Concrete Accessories.

2.8 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Curing Mats: Shall be heavy carpets or cotton mats, quilted at four inches on centers, and weighing minimum of 12 ounces per square yard when dry.

C. Moisture-Retaining Cover: Provide one of the following, complying with ASTM C171:
   1. Waterproof paper.
   2. Polyethylene film.
   3. White burlap polyethylene sheet.

D. Liquid Curing Compound: ASTM C309 Type 1-D (water retention requirements):
   1. Provide fugitive dye.
   2. Curing compound shall be applied by roller or power sprayer.
   3. Product shall be listed in NSF/ANSI 61.

2.9 FINISHING AIDS

A. Evaporation Retardant:
   1. Product and Manufacturer: Provide one of the following:
      a. Confilm, by Master Builders.
      b. Eucobar, by Euclid Chemical Company.
      c. SikaFilm, by Sika Corporation.
      d. Or equal.

2.10 CRACK INJECTION MATERIALS

A. Structural Crack Repair System:
   1. Epoxy for Injection: Low-viscosity, high-modulus moisture insensitive type.
   2. Products and Manufacturers: Provide one of the following:
      a. Sikadur 55 SLV or Sikadur 52 and Sikadur 31, Hi-Mod Gel, by Sika Corporation.
      b. Dural 335 by Euclid Chemical Company.
      c. Or equal.
   3. Product shall be listed in NSF/ANSI 61.

B. Non-structural Crack Repair System:
   1. Hydrophobic Polyurethane Chemical Grout:
      a. Provide hydrophobic polyurethane that forms a flexible gasket.
      b. Products and Manufacturers: Provide one of the following:
         1) SikaFix HH LV, by Sika Chemical Company.
         2) Hydro Active Flex SLV, by De Neef Construction Chemicals, Inc.

3) Or equal.
c. Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
d. Minimum elongation of 250 percent in accordance with ASTM D3574.
e. Minimum tensile strength of 150 psi in accordance with ASTM D3574.
f. Product shall be listed in NSF/ANSI 61.

2. Hydrophilic Acrylate-Ester Resin:
a. Hydrophilic crack repair system shall be acrylate-ester resin that forms a flexible gasket and increase in volume a minimum of 50 percent when in contact with water.
b. Products and Manufacturers: Provide one of the following:
1) Gelacryl Superflex AR manufactured by DeNeef Corporation.
2) AR870 manufactured by Prime Resins, Inc.
3) Or equal.
c. Product shall be listed in NSF/ANSI 61.

2.11 CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be pre-packaged, polymer-modified cementitious repair mortar with the following minimum properties:
1. Compressive Strength at One Day: 2,000 psi (ASTM C109).
2. Compressive Strength at 28 Days: 6,000 psi (ASTM C109).
3. Bond Strength at 28 Days: 1,800 psi (ASTM C882 modified).
a. Material shall be listed in NSF/ANSI 61.

B. Products and Manufacturers: Provide one of the following:
1. Five Star Structural Concrete, by Five Star Products, Inc. Use formulation recommended by manufacturer for the specific application conditions.
2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, by Sika Corporation. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
3. Emaco S88-CA or S66-CR, by Master Builders Inc. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
4. Verticoat, Verticoat Supreme, or Euco SR-VO, by Euclid Chemical Company. Use formulation from among those listed in this paragraph recommended by manufacturer for specific application conditions.
5. Or equal.

C. Cement Mortar: Shall consist of mix of one part cement to 1.5 parts sand with sufficient water to form trowelable consistency. Minimum compressive strength at 28 days shall be 4,000 psi. Where required to match the color of adjacent concrete surfaces, blend white portland cement with standard portland cement so that, when dry, patching mortar matches the color of surrounding concrete.

2.12 VAPOR RETARDER

A. Vapor Retarder:
1. Vapor retarder membrane shall comply with the following.
a. Water Vapor Transmission Rate, ASTM E96: 0.04 perms or lower.
b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
2. Products and Manufacturers: Provide one of the following:
a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.

b. Griffolyn 10-mil, by Reef Industries.
c. Moistop Ultra, by Fortifiber Industries.
d. Or equal.

B. Accessories:
1. Provide accessories by same manufacturer as vapor retarder.
2. Seam Tape:
a. Tape shall have water vapor transmission rate (ASTM E96) of 0.3 perms or lower.
b. Products and Manufacturers: Provide one of the following:
1) Stego Tape by Stego Industries LLC.
2) Griffolyn Fab Tape by Reef Industries.
3) Moistop Tape by Fortifiber Industries.
4) Or equal.
3. Vapor Proofing Mastic:
a. Mastic shall have a water vapor transmission rate ASTM E96, 0.3 perms or lower.
4. Pipe Boots:
a. Construct pipe boots from vapor barrier material, pressure sensitive tape, mastic, or a combination thereof, in accordance with manufacturer's recommendations.

2.13 SOURCE QUALITY CONTROL

A. Concrete materials may require testing, as directed by Engineer, at any time during the Work if concrete quality is in question. Provide access to material stockpiles and facilities at all times. Tests shall be done at no expense to Owner.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which the Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 CONCRETE MIXING

A. General:
1. Concrete may be produced at batch plants or by the ready-mixed process. Batch plants shall comply with requirements of ACI 301 and ACI 350.5 and have sufficient capacity to produce concrete of qualities required and in quantities required to comply with the accepted Progress Schedule. All plant facilities are subject to acceptance of Engineer.
2. Mixing:
a. Mix concrete with a rotating type batch machine, except where hand mixing of very small quantities is approved by Engineer.
b. Remove hardened accumulations of cement and concrete from drum and blades to ensure proper mixing action.
c. Replace mixer blades upon loss of ten percent of mixer blades' original height.

B. Site Mixing:
1. When Site mixing of concrete is approved by Engineer mix all materials for concrete in a drum-type batch mixer.

a. For mixers of one cubic yard or smaller capacity, continue mixing at least 1.5 minutes but not more than five minutes after all ingredients are in the mixer, before any part of batch is released.
b. For mixers of capacity larger than one cubic yard, increase minimum 1.5 minutes of mixing time by 15 seconds for each additional cubic yard or fraction thereof.

2. Do not exceed mixer manufacturer's published rating of the mixer, or mixer nameplate capacity, for total volume of materials used per batch.
3. Equip mixer with automatic controls for proportioning materials and proper, measured quantities.
4. Do not exceed 45 minutes total elapsed time between intermingling of damp aggregates and cement to discharge of completed mix.

C. Ready-Mix Concrete:
1. Comply with ASTM C94 and the Contract Documents.
a. Plant Equipment and Facilities: Conform to requirements of NRMCA certification.
b. Truck-Mixed Concrete: Mix concrete in revolving-type truck mixers that are in good condition and produce thoroughly-mixed concrete conforming to the Contract Documents. Truck shall operate at agitating speed after mixing is complete or 100 revolutions, whichever occurs first.
c. Central-Mixed Concrete: Truck shall operate at agitating speed while in transit.
d. Do not exceed rated capacity of mixer.
e. Mix concrete for minimum of two minutes after arrival at the Site, or as recommended by mixer manufacturer
f. Mix at proper speed until concrete is discharged from mixer.
g. Maintain adequate facilities at the Site for continuous delivery of concrete at required rates.
h. Provide access to mixing plant for Engineer upon request.

D. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery to prevent delay of placing concrete after mixing, or holding dry-mixed materials too long in mixer before the adding water and admixtures.

3.3 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients, unless a hydration controlling admixture is authorized by the Engineer.

B. Avoid spilling and separation of concrete mixture during transportation.

C. Do not place concrete in which the ingredients have separated.

D. Do not retemper partially set concrete.

E. Use suitable equipment for transporting concrete from mixer to forms.

3.4 PREPARATION FOR CONCRETING

A. Submit to Engineer laboratory trial batch test results for proposed mixes at least 15 days prior to start of Work. Do not begin concrete production until associated laboratory trial batch test result submittal has been approved by Engineer.

B. Notify Engineer a minimum of 24 hours in advance of placing concrete to allow for inspection of form work, joints, waterstops, reinforcement, embedded items, and vapor retarders. The section to be placed shall be fully prepared for concrete placement at the time of notice. Confirm inspection status with Engineer a minimum of 4 hours prior to concrete placement. Do not begin placing concrete until Work is in conformance with the Contract Documents.

C. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

D. Reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or other substances which would interfere with proper bonding with concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Any defects in the coating shall be repaired.

E. Do not place concrete until flow of water entering space to be filled with concrete has been properly stopped or has been diverted by pipes, or other means, and carried out of the forms, clear of the Work. Do not deposit concrete underwater, and do not allow water to rise on concrete surfaces until concrete has attained its initial set. Do not allow water to flow over concrete surface in manner and or velocity that will injure concrete surface finish. Provide temporary pumping or other dewatering operations for removing water as required.

F. Prepare joint surfaces in accordance with Section 03 1500, Concrete Accessories.

G. Installation of Vapor Retarder:
   1. Provide vapor retarder under slabs-on-grade and outside walls to receive resilient floor finishes, carpet, ceramic and slate tile, chemical resistant coatings, and where shown or indicated on the Drawings.
   2. Install in accordance with manufacturer's instructions, ASTM E1643, and the following:
      a. Unroll vapor retarder with longest dimension parallel with direction of the pour.
      b. Lap vapor retarder over footings and seal to foundation walls.
      c. Overlap vapor retarder joints by six inches and seal with vapor retarder manufacturer's tape.
      d. Seal penetrations, including pipes, in accordance with vapor retarder manufacturer's instructions.
      e. Penetration of vapor retarder is not allowed except for reinforcing steel and permanent utilities.
      f. Repair damaged areas of vapor retarder by providing, for each damaged area, patch of vapor retarder material and overlapping damaged area with the patch by six inches on each side, and securely and continuously taping all four sides of patch to undamaged vapor retarder.

3.5 CONCRETE PLACEMENT

A. General:
   1. Place concrete continuously, so that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If section cannot be placed continuously, provide construction joints in accordance with Section 03 1500, Concrete Accessories.

2. Deposit concrete as nearly as practical in its final location to avoid segregation due to re-handling or flowing. Do not subject concrete to action that may cause segregation. This requirement does not apply to self-consolidating concrete.
3. Screed concrete that is to receive other construction to proper level to avoid excessive skimming or grouting.
4. Do not use concrete that becomes non-plastic and unworkable, or does not conform to required quality limits, or that has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the Site and dispose of it in conformance with Laws and Regulations.
5. Do not place concrete until forms, bracing, reinforcing, and embedded items are each in final position and secure.
6. Do not place footings in freezing weather unless adequate precautions are taken against frost action.
7. Do not place footings, piers or pile caps on frozen soil.
8. Unless otherwise instructed, place concrete only when Engineer is present.
9. Allow minimum of three days between adjoining concrete placements. At expansion joints, allow minimum of one day between adjoining concrete placements.

B. Bonding for Next Concrete Pour:
1. Prepare for bonding of fresh concrete to concrete that has set but is not fully cured, as follows:
   a. The surface must be saturated surface dry.
   b. For horizontal surfaces place a six-inch layer of Construction Joint Grout, as specified in Section 03 6000, Grouting, over the hardened concrete surface.
   c. Place fresh concrete before the grout has attained its initial set.
2. Accomplish bonding of fresh concrete to fully cured, hardened, existing concrete by using a bonding agent as specified in Section 03 1500, Concrete Accessories.

C. Concrete Conveying:
1. Handle concrete from point of delivery at the Site, transfer to concrete conveying equipment, and transfer to locations of final deposit as rapidly as practical by methods that prevent segregation and loss of concrete mix materials.
2. Provide mechanical equipment for conveying concrete to ensure continuous flow of concrete at delivery end of conveyor. Provide runways for wheeled concrete conveying equipment from concrete delivery point to locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.
3. Do not use chutes for distributing concrete, unless accepted by Engineer.
4. Pumping concrete is allowed, however do not use aluminum pipe for conveying concrete.

D. Placing Concrete into Forms:
1. Deposit concrete in forms in horizontal layers not deeper than 18 inches each and in manner that avoids inclined construction joints. Where placement consists of several layers, place concrete at such rate that concrete being integrated with fresh concrete while still plastic.
2. Do not allow concrete to free-fall within the form from height exceeding four feet. Where high-range water reducer is used to extend slump to at least six inches, maximum allowable free-fall of concrete is six feet. Use “elephant trunks” to prevent free-fall and excessive splashing of concrete on forms and reinforcing. Discontinue free-falls in excess of four feet if there is evidence of segregation.
3. Remove temporary spreaders in forms when concrete placing has reached elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidating concrete in accordance with requirements of ACI 301. Vibration of forms and reinforcing is not allowed unless otherwise accepted by Engineer.
5. Where height of concrete placement in walls exceeds 14 feet, provide temporary windows in formwork to facilitate vibration. Properly close temporary windows when height of concrete approaches windows. Determine location, size, and spacing of temporary windows to suit equipment used.
6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly-spaced locations not farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate the layer of concrete and at least six inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcing and other embedded items without causing segregation of concrete mix.
7. Do not place concrete in beam and slab forms until concrete previously placed in columns and walls is no longer plastic.
8. Prevent voids in the concrete. Force concrete under pipes, sleeves, openings, and inserts from one side until visible from the other side.
9. Self-Consolidating Concrete (SCC) may be used with prior approval of the Engineer.

E. Placing Concrete Slabs:
1. Deposit and consolidate concrete slabs in continuous operation, within limits of construction joints, until placing of a slab panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcing and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified in this Article for formed concrete structures.
4. Bring slab surfaces to correct elevation and level. Smooth the surface, leaving surface free of humps or hollows. Do not sprinkle water on surface while concrete is plastic. Do not disturb slab surfaces prior to commencing concrete finishing.
5. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, provide evaporation retardant applied in accordance with retardant manufacturer's recommendations, when required by Engineer.

F. Placing Self-Consolidating Concrete
1. Place concrete at a rate in locations such that the surface of placed concrete does not lose flowability and plasticity and newly placed concrete can fully integrate with previously placed fresh concrete.
2. Insert pump hose to the bottom of the form at one end such that concrete does not impact reinforcing steel or the sides of forms. Class "SC" concrete shall not be allowed to free fall into the forms. Allow the concrete to flow laterally to fill the form. Raise pump hose or elephant trunk as the concrete level rises keeping the discharge below the concrete surface taking care to avoid trapping air.
3. Alternately, formwork can be designed to allow pumping of self-consolidating concrete from the bottom of the form.
4. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
5. Prevent voids in the concrete. Force concrete under pipes, sleeves, openings, and inserts from one side until visible from the other side.

6. Do not place concrete in beam and slab forms until concrete previously placed in columns and walls is no longer plastic.
7. Self-consolidating concrete shall not be vibrated unless there is evidence of incomplete consolidation and when authorized by the Engineer.
8. Placement of self-consolidating concrete in slabs shall be as specified in this Article except that vibration is not required

G. Quality of Concrete Work:
1. Concrete shall be solid, compact, and smooth, and free of laitance, cracks, and cold joints.
2. Concrete for liquid-retaining structures, and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to extent directed by Engineer, or repair to satisfaction of Engineer, defects as defined in 3.12. Thin patches or plastering are unacceptable.
4. Leaks through concrete that exhibit flowing water, and cracks, holes, or other defective concrete in areas of potential leakage, shall be repaired and made watertight.
5. Repair, removal, and replacement of defective concrete as directed by Engineer shall be at no additional cost to Owner.

H. Cold Weather Placing:
1. Protect concrete Work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures, in compliance with ACI 306.1 and the Contract Documents.
2. When air temperature has fallen to or may be expected to fall below 40 degrees F, provide adequate means to maintain temperature in area where concrete is being placed between 50 degrees F and 70 degrees F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain temporary heating and protection as necessary so that ambient temperature does not fall more than 30 degrees F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing for concrete as required to obtain concrete mixture temperature not less than 55 degrees F and not more than 85 degrees F at point of placement.
4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Before placing concrete, verify that forms, reinforcing, and adjacent concrete surfaces are entirely free of frost, snow, and ice.
5. Use only specified accelerating admixtures approved for use. Do not use salt or other materials containing antifreeze agents.

I. Hot Weather Placing:
1. When hot weather conditions exist that would impair the quality and strength of concrete, place concrete in compliance with ACI 305 and the Contract Documents.
2. When ambient air temperature is at or above 90 degrees F and rising, cool ingredients before mixing concrete to maintain concrete temperature at time of placement below 80 degrees F. When ambient air temperature is at or above 90 degrees F and falling, cool the ingredients before mixing concrete to maintain concrete temperature at time of placement below 85 degrees F. In no case shall the concrete temperature at time of placement exceed 90 degrees F.
3. Mixing water may be chilled, or chopped ice may be used to control concrete temperature provided the water equivalent of ice is calculated in total amount of mixing water. If

required, reduce the time from addition of mix water to placement, or use set-retarding admixture.

4. Cover reinforcing materials with water-soaked burlap if ambient air temperature becomes too hot, so that reinforcing material temperature does not exceed ambient air temperature immediately before embedment of reinforcing in concrete.
5. Wet forms thoroughly before placing concrete.
6. Do not place concrete at temperature that causes difficulty from loss of slump, flash set, or cold joints.
7. Use of set-control admixtures shall be as approved by Engineer.
8. Obtain Engineer's approval of substitute methods and materials proposed for use.

J. Underwater Placing:

1. Concrete placement in water will be allowed if conditions render it impossible or inadvisable to dewater excavations or liquid-retaining structures before placing concrete, and only when allowed by Engineer in writing.
2. Revise and submit concrete mix design to suit underwater placement, and obtain Engineer’s approval before commencing underwater placement of concrete. Deposit concrete by tremie method or other suitable means in continuous placement to prevent forming layers or intrusion of water.

3.6 FINISHING OF FORMED SURFACES

A. Standard Form Finish:

1. Standard form finish shall be basically smooth and even, but is allowed to have texture imparted by the form material used. Repair defects in accordance with the Contract Documents.
2. Use standard form finish for the following:
   a. Exterior vertical surfaces from foundation up to one foot below grade.
   b. Vertical surfaces not exposed to view.
   c. Other areas shown or indicated.

B. Smooth Form Finish:

1. Produce smooth form finish by selecting form materials that will impart smooth, hard, uniform texture. Arrange panels in orderly and symmetrical manner with minimum of seams. Repair and patch defective areas in accordance with the Contract Documents.
2. Use smooth form finish for the following:
   a. Exterior surfaces exposed to view.
   b. Surfaces to be covered with coating material. Coating material may be applied directly to concrete or may be a covering bonded to concrete such as waterproofing, dampproofing, painting, or other similar system.
   c. Interior vertical surfaces of liquid-containers.
   d. Interior and exterior exposed beams and undersides of slabs.
   e. Surfaces to receive abrasive blasted finish.
   f. Surfaces to receive smooth rubbed or grout cleaned finish.
   g. Other areas shown or indicated.

C. Grout Cleaned Finish:

1. Provide grout cleaned finish to concrete surfaces that have received smooth form finish and where defects have been repaired, as follows:
   a. Combine one part Portland cement to 1.5 parts fine sand by volume, and mix with water to consistency of thick paint. Blend standard Portland cement and white

Portland cement, in proportions determined by trial patches, so that final color of dry grout will closely match adjacent concrete surfaces.

b. Thoroughly wet concrete surface and apply grout uniformly by brushing or spraying immediately to wetted surfaces. Scrub surface with cork float or stone to coat surface and fill surface holes. Remove excess grout by scraping, followed by rubbing with clean burlap to remove visible grout film. Keep grout damp during setting period by using fog spray on surface for at least 36 hours after final rubbing. Complete each area the same day the area is started, with limits of each area being natural breaks in the finished surface.

2. Use grout cleaned finish for the following:
   a. Interior exposed walls and other vertical surfaces.
   b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
   c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
   d. Interior exposed vertical surfaces of liquid-containing structures down to one foot below normal operating liquid level.
   e. Other areas shown.

D. Related Unformed Surfaces:
   1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown or indicated.

3.7 SLAB FINISHES

A. Float Finish:
   1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Check and level the surface plane to tolerance not exceeding 1/4-inch in ten feet when tested with a ten-foot straightedge placed on surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to uniform, smooth, granular texture.
   2. Use float finish for the following:
      a. Interior exposed horizontal surfaces of liquid-containing structures, except those to receive grout topping.
      b. Exterior below-grade horizontal surfaces.
      c. Surfaces to receive additional finishes, except as shown or indicated.

B. Trowel Finish:
   1. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
   2. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten foot straight edge. Grind smooth surface defects that would otherwise project through applied floor covering system.
   3. Use trowel finish for the following:
      a. Interior exposed slabs, unless otherwise shown or indicated.
      b. Slabs that receive one of the following: resilient flooring, carpeting, or ceramic tile.

C. Non-Slip Broom Finish:

1. Immediately after float finishing, slightly roughen concrete surface by brooming in direction perpendicular to main traffic route. Use fine fiber-bristle broom, unless otherwise directed by Engineer. Coordinate required final finish with Engineer before applying finish.
2. Use non-slip broom finish for the following:
    a. Exterior exposed horizontal surfaces subject to lightweight foot traffic.
    b. Interior and exterior concrete steps and ramps.

D. Scratched Finish:
1. After providing float finish, roughen concrete surface with rake before concrete's final set. Amplitude of surface shall be minimum of 1/4-inch.
2. Provide scratched finish for the following:
    a. Horizontal surfaces that will receive grout topping or concrete equipment pad.
    b. Surfaces so indicated on the Drawings or elsewhere in the Contract Documents.

3.8 CONCRETE CURING AND PROTECTION

A. General:
1. Protect freshly placed concrete from premature drying, excessive cold or hot temperatures, and maintain without drying at relatively constant temperature for period necessary for hydration of cement and proper hardening of concrete.
2. Start curing after placing and finishing concrete, as soon as free moisture has disappeared from concrete surface. Keep surface continuously moist during entire curing period. Cure for a minimum of 10 days and in accordance with requirements of ACI 301 and ACI 308.1. For concrete sections over 30-inches thick, the curing period shall be for a minimum of 14 days. Avoid rapid drying at end of final curing period.
3. For curing, use water that is free of impurities that could etch or discolor exposed concrete surfaces.
4. Confine water for curing to area being cured.

B. Curing Methods: Curing methods are specified below. Curing methods to be used on each type of concrete surface are specified elsewhere in this Article.
1. Water Curing. Cure by one of the following methods:
    a. Keep concrete surface continuously wet.
    b. Ponding or immersion.
    c. Continuous water-fog spray.
    d. Covering concrete surface with curing mats, thoroughly saturating mats with water, and keeping mats continuously wet with sprinklers or porous hoses. Place curing mats to cover concrete surfaces and edges with four-inch horizontal lap over adjacent mats; provide eight-inch lap over adjacent mats at vertical surfaces. If necessary, weigh down curing cover to maintain contact with concrete surface.
2. Form Curing. Cure by one of the following methods:
    a. Forms shall be maintained and loosened during curing period.
    b. Immediately after forms are loosened or removed, continue with the required curing method as applicable, for remainder of curing period.
    c. Where wood forms are kept in place, apply water to keep forms wet.
3. Moisture Retaining Cover Curing. Cure as follows:
    a. Cover concrete surfaces with the required moisture retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least three inches and sealed using waterproof tape or adhesive. Immediately repair holes or tears during curing period using cover material and waterproof tape.

4. Liquid Compound Curing. Cure as follows:
    a. Unless otherwise approved by Engineer, provide water curing or form curing. Request to use liquid curing compound will be considered by Engineer on case-by-case basis. Construction joints, formed surfaces prior to receiving specified form finish, and concrete to receive surface treatment where surface treatment will be bonded to concrete surface (such as, but not limited to grout fill, hardener, coatings, lining, water repellent, painting, resilient flooring, terrazzo flooring, ceramic tile, quarry tile, chemical resistant coatings, or other applications) shall be water-cured or form-cured.
    b. In liquid-retaining structures, provide water curing or form curing, unless other curing method is approved by Engineer. Requests to use liquid curing compound will be considered by Engineer on case-by-case basis. Request shall provide valid construction reason or safety reason for using liquid compound curing including reason why other curing methods are not viable.
    c. Apply curing compounds immediately after final finishing or after terminating water curing. Apply curing compound in continuous operation by power spray equipment in accordance with curing compound manufacturer's directions. If areas are subjected to rainfall within three hours after completing curing compound application, area shall be recoated. Maintain coating continuity and repair areas damaged during curing period.
    d. When liquid curing compound is used, apply first coat of liquid curing compound at compound manufacturer's recommended coverage rate, and subsequently apply second coat at identical rate, thus providing twice the curing compound manufacturer's recommended coverage.
    e. At end of curing period, remove liquid curing compound where required.

C. Formed Surfaces: Use the following curing methods:
1. Walls That Will Retain Liquid or That are Under Ground Surface:
    a. If forms are wood, form curing is allowed for entire curing period. If forms are steel, form curing is allowed for maximum of three days after which forms shall be removed so that concrete is free of the forms for remainder of the curing process.
    b. Immediately after the forms are loosened or removed, continue with water curing for remainder of curing period.
    c. When wall surface will not receive surface treatment and when allowed by Engineer, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.
2. Formed Slab Underside and Beam Surfaces Where Will Retain Liquid:
    a. Form curing is allowed for the full curing period.
    b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.
    c. When slab surface will not receive surface treatment and when allowed by Engineer, use of liquid curing compound is allowed.
3. Vertical Joint Surfaces and Surfaces to Receive Surface Treatment:
    a. Form curing is allowed for entire curing period.
    b. Immediately after forms are loosened or removed, continue with water curing for remainder of curing period.
4. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

D. Unformed Surfaces: Treat with one of the following curing methods:
1. Slabs and Mats That Will Retain Liquid or are Below Ground Surface:

a. Water curing.
b. Moisture-retaining cover curing when allowed by Engineer.
c. When slab or mat surface will not receive surface treatment and when allowed by Engineer, use of liquid curing compound is allowed. Before using liquid compound curing, use water curing or form curing for at least the first three days of curing.

2. Construction Joint Surfaces and Slab and Mat Surfaces to Receive Surface Treatment.
   a. Water curing.
   b. Moisture-retaining cover curing.
3. Cure other formed surfaces using an appropriate curing method specified in the Contract Documents.

E. Temperature of Concrete During Curing:
1. When ambient temperature is 40 degrees F or less, continuously maintain concrete temperature between 50 degrees F and 70 degrees F throughout curing period. When necessary, before concrete placing provide for temporary heating, covering, insulation, or housing as required to continuously maintain specified temperatures and moisture conditions throughout concrete curing period. Provide cold weather protection in accordance with requirements of ACI 306.1.
2. When the ambient temperature is 80 degrees F and above, or during other climatic conditions that would cause too-rapid drying of concrete, before starting concrete placing, provide wind breaks and shading as required, and fog spraying, wet sprinkling, or moisture retaining coverings as required. Continuously protect concrete throughout concrete curing period. Provide hot weather protection in accordance with requirements of ACI 305.1, unless otherwise specified.
3. Maintain concrete temperature as uniformly as possible, and protect from rapid ambient temperature changes. Avoid concrete temperature changes that exceed five degrees F in one hour and 50 degrees F in 24-hour period.

F. Protection:
1. During curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and damage by rain and flowing water. Protect finished concrete surfaces from damage by subsequent construction operations.

3.9 Concrete installation Tolerances

A. Installation Tolerances:
1. Concrete placement tolerances, unless otherwise specified in the Contract Documents, shall be in accordance with ACI 117. Tolerances for concrete cover shall be as required by Section 03 2000, Concrete Reinforcing.
2. Notify Engineer in writing when concrete placement does not conform with required tolerances, as soon as the condition is known to Contractor.
3. When concrete installation does not conform to required tolerances, do not repair or correct by grinding unless specified in the Contract Documents or approved by Engineer in writing.
4. Verification Measurements:
   a. If surfaces where tolerances are in question, obtain measurements to verify conformance with tolerances in manner acceptable to Engineer.
   b. If surfaces tolerances are in question, cost of obtaining measurements shall be at no additional cost to the Owner.
   c. Before obtaining measurements, obtain Engineer's acceptance of method proposed for obtaining measurements.

d. After obtaining measurements, submit measurements to Engineer.

5. Submit with verification measurements submittal proposed method to rectify out-of-tolerance concrete. Do not start repair Work without obtaining Engineer's approval.

3.10 FIELD QUALITY CONTROL

A. Field Testing Services:
1. Owner will employ testing laboratory to perform field quality control testing for concrete. Engineer will direct the testing requirements.
2. Testing laboratory will make standard compression test cylinders and entrained air tests as specified in this Article, under observation of Engineer or Resident Project Representative.
3. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.

B. Quality Control Testing During Construction:
1. Perform sampling and testing for field quality control during placement of concrete, as follows:
   a. Sampling Fresh Concrete: ASTM C172.
   b. Slump: ASTM C143; one test for each concrete load at point of discharge. For Class "SC" concrete, determine slump flow and visual stability index per ASTM C1611, one test for every two concrete loads at point of discharge and when a change in the concrete is observed and determine passing ability per ASTM C1621 when directed by Engineer.
   c. Concrete Temperature: ASTM C1064; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
   d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
   e. Unit Weight: ASTM C138; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
   f. Compression Test Specimens:
      1) In accordance with ASTM C31; make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by Engineer.
      2) Cast, store, and cure specimens in accordance with ASTM C31.
      3) Test and record the following when cylinders are cast: slump, concrete temperature, air content, and unit weight. For Class "SC" determine slump flow and visual stability index per ASTM C1611 instead of slump.
   g. Compressive Strength Tests:
      1) In accordance with ASTM C39; one specimen tested at seven days, and two specimens tested at 28 days. Test fourth cylinder if needed to verify test results.
      2) Adjust mix design if test results are unsatisfactory and resubmit for approval.
      3) Concrete that does not comply with strength requirements will be considered as defective Work.
   h. Water/Cementitious Materials Ratio: Perform test when required by Engineer in accordance with AASHTO T318.
   i. Within 24 hours of completion of test, testing laboratory will submit certified copy of test results to Contractor and Engineer.

C. Evaluation of Field Quality Control Tests:
   1. Do not use concrete delivered to final point of placement having slump, concrete temperature, total air content or unit weight outside specified values.
   2. Water/Cementitious Materials Ratio:
      a. When water content testing indicates water/cementitious materials ratio to exceed specified requirements by greater than 0.02, remaining batches required to complete concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as required to bring subsequently-batched concrete within specified water/cementitious materials ratio.
      b. Perform additional testing to verify compliance with specified water/cementitious materials ratio.
      c. Do not resume concrete production for further concrete placement until Contractor has identified cause of excess water in the mix and revised batching procedures, or adjusted the mix design (and obtained Engineer's associated approval) to bring water/cementitious materials ratio into conformance with the Contract Documents.
   3. Compressive Strength:
      a. Compressive strength tests for laboratory-cured cylinders will be acceptable if the averages of all sets of three consecutive compressive strength tests results equal or exceed specified 28-day design compressive strength of the associated type or class of concrete, and no individual strength test falls below required compressive strength by more than 500 psi.
      b. Questionable Field Conditions During Concrete Placement:
         1) Where questionable field conditions exist during concrete placement or immediately thereafter, strength tests of specimens cured under field conditions will be required by Engineer to check adequacy of curing and protecting of concrete placed. Specimens shall be molded at the same time and from the same samples as laboratory-cured specimens.
         2) Provide improved means and procedures for protecting concrete when 28-day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory cured cylinders.
         3) When laboratory-cured cylinder strengths are appreciably higher than minimum required compressive strength, field-cured cylinder strengths need not exceed minimum required compressive strength by greater than 500 psi even though the 85 percent criterion may not be met.
         4) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to ensure that load-bearing capacity of the structure is not jeopardized or impaired. If likelihood of low-strength concrete is confirmed and evaluations indicate load-bearing capacity may have been reduced, perform tests of cores from the concrete in question at Contractor's expense.
      c. If compressive strength tests fail to indicate compliance with minimum requirements of the Contract Documents, concrete represented by such tests will be considered defective.

D. Testing Concrete Structure for Strength:
   1. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, Contractor shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42 and the following:

a. Obtain at least three representative cores from each concrete member or suspect area of concrete at locations directed by Engineer.
b. Strength of concrete for each series of cores will be acceptable if average compressive strength is at least 85 percent of specified compressive strength and no single core is less than 75 percent of required 28-day required concrete compressive strength.
c. Testing laboratory shall submit test results to Engineer on same day that tests are completed. Include in test reports Project name and number (if any), date of sampling and testing, Contractor name, name of concrete testing laboratory, exact location of test core in the Work, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength, and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of the core at time of testing.

2. Fill core holes solid with non-shrink grout in accordance with Section 03 6000, Grouting, and finish to match adjacent concrete surfaces.
3. If results of core tests are unacceptable or if it is impractical to obtain cores, perform static load test and evaluations complying with ACI 318 and ACI 350, as directed by Engineer.

E. Concrete Tolerance Verification Measurements: Refer to Article 3.9 of this Section.

F. Supplier's Services:
1. Water-Reducing Admixture Manufacturer: Furnish services of qualified concrete technician employed by admixture manufacturer to assist in proportioning concrete for optimum use of admixture. Concrete technician shall advise on proper addition of admixture to concrete and on adjustment of concrete mix proportions to meet changing conditions at the Site.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings:
1. Openings in concrete walls and slabs required for passage of Work are allowed only upon approval of Engineer.
2. Temporary openings made in concrete shall be provided with waterstop in below-ground or liquid-retaining members and structures. Reinforcement going through and around the opening shall be made continuous to provide continuity and shall be approved by the Engineer.
3. Temporary openings that remain in concrete structures shall be filled with the same class of concrete as the adjoining construction, after the Work causing need for temporary opening is complete, unless otherwise shown or directed by Engineer. Mix, place, and cure concrete as specified in this Section to blend with in-place construction. Provide miscellaneous concrete filling shown or required to complete the Work.

B. Bases or Pads for Piping, Panels, and Equipment:
1. Unless specifically shown or indicated otherwise, provide concrete bases or pads for equipment, floor-mounted panels, and floor-mounted supports for piping and similar construction. Provide all concrete pad and base Work not specifically included under other Sections.
2. Dimensions and Elevations:

a. Coordinate and construct bases and pads to dimensions shown or indicated, or as required to comply with equipment, panel, or piping manufacturer's requirements and elevations indicated on the Drawing.
b. Unless otherwise shown or indicated, place concrete bases for equipment up to one-inch below the equipment manufacturer's base or mounting plate.
c. Where specific dimensions or elevations are not shown or indicated, bases and pads shall be six inches thick and extend three inches outside dimensions of the equipment, panel, or supports.

3. Finish: Bases and pads outside of areas to receive non-shrink grout shall have smooth trowel finish, unless special finish such as terrazzo, ceramic tile, quarry tile, or heavy-duty concrete topping is required. In such cases, provide appropriate concrete finish. Surfaces of bases and pads to receive non-shrink grout shall have broom finish.

C. Curbs:
1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green followed by steel-troweling surfaces to hard, dense finish with corners, intersections, and terminations slightly rounded.
2. Exterior curbs shall have rubbed finish for vertical surfaces and broomed finish for top surfaces.

3.12 REPAIR OF CONCRETE PLACED UNDER THIS CONTRACT

A. Repair of Formed Surfaces:
1. Repair the following defects in all formed finishes:
a. Spalls, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
b. Holes from tie rods and other form tie systems.
c. Fins, offsets, and other projections that extend more than 1/4-inch beyond designated concrete member surface.
d. Structural cracks, as defined by Engineer.
e. Non-structural cracks greater than 0.010-inch wide as defined by Engineer. In liquid-retaining structures, elevated slabs subject to the elements or washdowns, below-grade members, and cracks that evidence leakage. Where it is not possible to verify whether a crack is leaking, repair the crack.
2. Repair the following defects in smooth-finish surfaces, in addition to those listed above in this Section:
a. Spalls, air bubbles, rock pockets, form depressions, and other defects that extend to more than 1/2-inch in width in any direction, no matter how deep.
b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch by 12-inch area, or 12 in number in a three-foot by three-foot area.
c. Fins, offsets, and other projections shall be completely removed and smoothed.
d. Scratches and gouges in concrete surface.
e. Texture and color irregularities. In liquid-retaining surfaces, texture and color irregularities need not be repaired when greater than 12 inches below minimum normal operating liquid surface elevation, except where such defects are indicative of reduced durability.
3. Where smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to finish application, when approved by Engineer.

B. Method of Repair of Formed Surfaces:
   1. Immediately after removing forms, repair and patch defective areas with cement mortar or concrete repair mortar as directed by Engineer. Make repairs made to liquid-retaining structures and below-grade surfaces with repair mortar only. Repair form tie holes in liquid-retaining or below-grade surfaces with non-shrink grout in accordance with Section 03 6000, Grouting.
   2. Honeycombs, Rock Pockets, and Holes Left by Tie Rods and Bolts:
      a. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to depth less than one-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to concrete surface.
      b. Before placing cement mortar, thoroughly clean and brush-coat area to be patched with specified bonding agent.
      c. When using concrete repair mortar, use of bonding agent is optional; prepare the surface and place mortar in accordance with mortar manufacturer's recommendations.
      d. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for interior surfaces of liquid-retaining surfaces up to one foot below typical minimum liquid level. Impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture, and color match before proceeding with patching.
      e. Compact mortar in place and strike off slightly higher than the surrounding surface.
   3. Structural Cracks: Pressure-grout structural cracks using injectable epoxy installed using pressurized system. Apply in accordance with epoxy manufacturer's directions and recommendations.
   4. Non-structural Cracks: Shall be pressure-grouted using injection material specified in paragraph 2.10.B. Install in accordance with manufacturer's directions and recommendations.
   5. Determination of the crack type shall be made by the Engineer.
   6. Holes Through Concrete:
      a. Using plunger-type gun or other suitable device, fill holes extending through concrete from least-exposed face, using flush stop held at exposed face; completely fill the hole with specified repair material.
      b. At below-grade and liquid-containing members, fill holes with concrete repair mortar and use color-matched cement mortar for outer two inches at exposed-to-view surfaces.
   7. Where powerwashing or scrubbing is not adequate, abrasive blast exposed- to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

C. Repair of Unformed Surfaces:
   1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to specified tolerances for each surface and finish. Correct low and high areas in accordance with this Section.
   2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using template having the required slope. Correct high and low areas in accordance with this Section.
   3. Repair finish of unformed surfaces containing defects that adversely affect concrete durability. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.

4. Repair structural cracks in all structures and non-structural cracks in liquid-retaining structures. In liquid-retaining structures, where dry face of concrete member can be observed, repair all cracks evidencing any rate of water flow through crack. Where dry face of member cannot be observed, repair all cracks.

D. Methods of Repair of Unformed Surfaces:
   1. Correct high areas in unformed surfaces by grinding, after concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
   2. Correct low areas in unformed surfaces, during or immediately after completion of surface finishing, by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where repairs are required and concrete has already set, sawcut around perimeter of area to be repaired to depth of 1/2-inch and remove concrete so that minimum thickness of repair is 1/2-inch. Apply specified concrete repair mortar in accordance with repair mortar manufacturer's directions and recommendations.
   3. Repair defective areas, except random cracks and single holes not exceeding one-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Minimum thickness of repair shall be 1.5 inches. Dampen concrete surfaces in contact with patching concrete and brush with specified bonding agent. Place patching concrete while bonding agent is tacky. Mix patching concrete of same materials and proportions to provide concrete of same classification as original, adjacent concrete. Place, compact, and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
   4. Repair isolated, random, non-structural cracks (in members that are not below grade or liquid-retaining), and single holes not greater than one-inch diameter, by dry-pack method. Groove top of cracks, and cut out holes to sound concrete, and clean repair area of dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2.5 parts fine aggregate passing No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for at least 72 hours.
   5. Structural cracks shall be pressure-grouted using injectable epoxy. Apply in accordance with epoxy manufacturer's directions and recommendations.
   6. Non-structural cracks in below-grade and liquid-retaining structures shall be pressure-grouted using injection material specified in paragraph 2.10.B. Apply in accordance with resin manufacturer's directions and recommendations.
   7. Determination of crack type will be by Engineer.
   8. Ensure that surface is acceptable for flooring material to be installed in accordance with flooring manufacturer's recommendations.

E. Other Methods of Repair:
   1. Repair methods not specified in this Section may be used when approved by Engineer.

END OF SECTION 03 3000

SECTION 03 4113

PRECAST CONCRETE HOLLOW CORE PLANKS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to design, furnish, and install precast concrete hollow core planks.
   2. The Work also includes:
      a. Providing openings in precast concrete plank units to accommodate the Work under this and other Sections and building into precast concrete plank units items such as sleeves, anchor systems, and inserts.

B. Coordination:
   1. Review applicable installation procedures under other Sections and coordinate installation of items to be installed prior to or in precast concrete hollow core planks.

C. Related Sections:
   1. Section 03 3000, Cast-in-Place Concrete.
   2. Section 03 6000, Grouting.
   3. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 211.3R, Guide for Selecting Proportions for No-Slump Concrete.
   2. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
   3. ASTM A36/A36M, Specification for Carbon Structural Steel.
   4. ASTM A108, Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   5. ASTM A123/A123M, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
   6. ASTM A416/A416M, Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
   7. ASTM C33/C33M, Specification for Concrete Aggregates.
   8. ASTM C150/C150M, Specification for Portland Cement.
   9. ASTM C494, Specification for Chemical Admixtures for Concrete.
   10. ANSI/AWS D1.1/D1.1M, Structural Welding Code – Steel.
   11. PCI TR-6, Interim Guidelines for the Use of Self-Consolidating Concrete.
   12. PCI MNL 116, Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products.
   13. PCI MNL 120, Design Handbook – Precast and Prestressed Concrete.
   14. PCI MNL 126, Manual for the Design of Hollow Core Slabs.
   15. PCI MNL 135, Tolerance Manual for Precast and Prestressed Concrete Construction.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
    a. Manufacturer shall be regularly engaged in manufacturing precast concrete hollow plank units for not less than five years. Manufacturer shall participate in PCI's plant certification program, and facility producing materials for the Project shall be certified by PCI.
    b. Submit a current PCI certificate of compliance designating certification in PCI Category C2 or C2A – Prestressed Hollow-Core and Repetitive Products.
2. Professional Engineer:
    a. Contractor or precast concrete hollow plank units manufacturer shall retain a registered professional engineer legally qualified to practice in the jurisdiction where the Site is located. Professional engineer shall have not less than five years' experience designing precast concrete hollow plank units.
    b. Responsibilities shall include:
        1) Reviewing precast concrete hollow plank units performance and design criteria shown and indicated in the Contract Documents.
        2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
        3) Preparing or supervising preparation of design calculations verifying compliance of precast concrete hollow plank units with requirements of the Contract Documents.
        4) Signing and sealing all calculations.
        5) Certifying that:
            a) Design of precast prestressed hollow plank units was performed in accordance with performance and design criteria shown and indicated in the Contract Documents, and
            b) Design complies with Laws and Regulations, and prevailing standards of practice.
3. Installer:
    a. Retain a single installer trained and possessing a record of successful experience installing precast concrete hollow plank units in accordance with recommendations and requirements of manufacturer, or shall provide evidence of being acceptable to the manufacturer.
    b. Installer shall employ only tradesmen with specific skill and successful experience in the type of Work required.
    c. When requested by Engineer, submit name and qualifications of installer with the following information for not less than three successful, completed projects:
        1) Names and telephone numbers of owner and architect or engineer responsible for each project.
        2) Approximate contract cost of precast concrete hollow plank units for which installer was responsible.
        3) Quantity, in square feet, of precast concrete hollow plank units installed.
4. Welders and Welding Processes:
    a. Qualify welding processes and welding operators in accordance with ANSI/AWS D1.1/D1.1M, Section 5, Qualification.
    b. Submit certification that each welder employed on or to be employed for the Work possesses current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.

B. Component Supply and Compatibility:
    1. Obtain all materials included in this Section regardless of component manufacturer, from a single precast concrete hollow plank units manufacturer.

2. Precast concrete hollow plank units manufacturer shall review and approve or prepare all Shop Drawings and other submittals (except for delegated design submittals, when professional engineer is retained by other than precast concrete hollow plank units manufacturer) for all components furnished under this Section.
3. Components shall be suitable for specified service conditions and shall be integrated into overall assembly by precast concrete hollow plank units manufacturer.

C. Regulatory Requirements:
1. Comply with Laws and Regulations, including applicable building code. Comply with building code requirements that are more stringent than ACI 318

D. Certifications:
1. Submit certification, signed by authorized officer of manufacturer and notarized, stating that precast concrete hollow plank units comply with the design prepared by the professional engineer.
2. Submit certification, signed by authorized officer of CONTRATOR and notarized, stating that all components are furnished by the same manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Complete details for fabricating and installing precast concrete hollow plank units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, camber, openings, headers, extent and location of each finish, if any, support conditions, bearing pads, and reinforcing.
b. Show or indicate location and details of anchorage systems to be embedded in or attached to precast concrete hollow plank units and other, related construction. Submit setting diagrams, templates, instructions, and directions, as required, for installation.
c. Indicate on plans the locations of each opening larger than eight inches in any dimension. Indicate each unit by same identification mark placed on the unit.
d. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
2. Product Data:
a. Manufacturer's literature, specifications, and load tables for materials to be used in precast concrete hollow plank unit Work.
3. Delegated Design Submittals:
a. Design Data:
1) Complete design computations of each precast concrete hollow plank unit, including the axial forces and diaphragm forces due to lateral loads and of the connections. Computations shall be signed and sealed by professional engineer. Professional engineer's seal shall be clearly legible, including jurisdiction of registration, registration number, and name on seal.
2) Certification by professional engineer that design of precast concrete hollow plank units was performed in accordance with performance and design criteria stated in the Contract Documents, and that design complies with Laws and Regulations and prevailing standards of practice.

B. Informational Submittals: Submit the following:

1. Certificates:
    a. Manufacturer's certification of compliance with professional engineer's design, as required in Article 1.3 of this Section.
    b. Contractor's certification on source of supply, as required in Article 1.3 of this Section.
2. Manufacturer's Instructions:
    a. Instructions and recommendations for handling, storing, protecting the products furnished.
    b. Installation instructions for the products furnished, including setting drawings, templates, and directions and tolerances for installing anchorage systems.
3. Source Quality Control Submittals:
    a. Laboratory test results, evaluation reports, and other data as required for the source quality control tests and inspections required in this Section to demonstrate compliance with the Contract Documents for the following materials:
        1) Concrete materials, cylinders, and mix design tests.
        2) Certified copies of mill reports covering chemical and physical properties of miscellaneous metal materials.
4. Supplier Reports:
    a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
5. Qualifications Statements: Submit qualifications for the following:
    a. Manufacturer, when requested by Engineer.
    b. Professional engineer.
    c. Installer.
    d. Welders' certifications.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
1. Store and support units adequately to prevent contact with soil, and to protect units from staining, cracking, distortion, warping or other physical damage.

B. Handling of Products:
1. Handle and transport units in a position consistent with their shape and design to avoid excessive handling stresses that could cause cracking or damage.
2. Lift and support units only at designated points shown on the Shop Drawings.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
1. Design and fabricate precast concrete plank units to support superimposed dead loads and live loads, equipment loads, and diaphragm loads specified or indicated on the Drawings, in addition to the dead weight load of the precast concrete plank units and construction loads. Coordinate with manufacturer relative to required superimposed loads.
2. Prestressing with lateral eccentricity shall be considered in design of precast concrete plank units. Horizontal misalignment due to eccentricity shall be avoided.
3. Comply with ACI 318 and the design recommendations of PCI MNL 120 and PCI MNL 126, applicable to type of structural precast concrete units required.

2.2 MATERIALS

A. Concrete:
   1. Portland cement shall comply with ASTM C150/C150M, Types I, II, or III.
   2. Aggregate shall comply with ASTM C33/C33M, for fine to coarse gradation.
   3. Admixtures: Chemical admixtures shall comply with ASTM C494. Do not use calcium chloride.
   4. Water shall be free of foreign materials in quantities harmful to concrete.

B. Prestressing strands shall be uncoated, seven-wire, stress-relieved strands complying with ASTM A416/A416M, Grade 250 or Grade 270.

C. Bearing pads shall be an engineered, multipolymer plastic with compressive strength of not less than 6,000 psi.

D. Anchoring:
   1. Embedded connection plates and anchorage systems shall be as shown and as required for anchoring units.
   2. Plates shall have thickness of not less than 1/4 inch, unless otherwise shown, and shall comply with ASTM A36/A36M.
   3. Anchorage: Headed stud type shear connectors shall comply with ASTM A108.

E. Fabricate headers required to safely carry design loads of hot-dip galvanized steel complying with ASTM A36/A36M and ASTM A123/A123M. Headers shall be prime-coated in the shop in accordance with Section 09 9100, Painting.

F. Grout for joints shall be one part portland cement to 2.5 parts sand.

2.3 MIXES

A. Mix design shall be in accordance with ACI 211.3R.

2.4 FABRICATION

A. Type: Machine-made, precast prestressed concrete units with open voids running the full length of slabs, produced under a rigid factory-inspected process acceptable to Engineer.

B. Compressive Strength: Manufacture units of concrete materials that provide compressive strength of not less than 3,000 psi at time of initial prestress and a 28-day compressive strength of not less than 5,000 psi.

C. Construction, Texture, and Finish:
   1. Provide precast concrete plank units that are free of unplanned voids and honeycomb, with straight, true edges and surfaces.
   2. Provide units of uniform color, free of stains and discoloration. Top surface shall have a float-finish free of holes. Bottom surfaces shall have smooth-form finish in accordance with Section 03 3000, Cast-in-Place Concrete.
   3. Top surface of precast concrete hollow plank units to receive topping shall have a scratched finish (raked) in accordance with Section 03 3000, Cast-in-Place Concrete.

D. Pretension prestressing strands by either a dead weight system or a single-strand jacking system. Mark strands for slippage and, when slippage occurs, detention and restress strand. Check tension of strand to ensure accurate results.

E. Release strands when concrete reaches compressive strength of not less than 3,000 psi, as required by the design.

F. Adequately reinforce plank units to resist transporting and handling stresses.

G. Include cast-in weld plates, where required, for anchorage or lateral bracing to structural steel members.

H. Identification: Provide permanent markings as shown on the approved Shop Drawings. Markings shall not show in the finished Work.

I. Provide headers of structural steel shapes for openings larger than one plank width in accordance with hollow plank unit manufacturer's recommendations.

J. Curing: Precast concrete plank units may be wet- or steam-cured in accordance with PCI MNL 116.

2.5 SOURCE QUALITY CONTROL

A. Fabrication Tolerances: Fabricate hollow core plank units to comply with the following fabrication dimensional tolerances:
   1. Length: Plus or minus 1/2-inch.
   2. Width: Plus or minus 1/4-inch.
   3. Depth: Plus or minus 1/4-inch.
   4. Position of Weld Plates: Plus or minus one-inch.
   5. Differential Camber Between Adjacent Members from the Bottom Side of Plank: 1/4-inch in ten feet, and not greater than 1/2-inch.
   6. Horizontal Misalignment or Sweep: Plus or minus 1/8-inch in ten feet, but not greater than plus or minus 3/8-inch over entire length.

B. Tests and Inspections:
   1. Test and inspect precast concrete in accordance with PCI MNL 116.
   2. When using self-consolidating concrete, also test and inspect in accordance with PCI TR-6.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which the Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Installation – General:

1. Lift, place, and secure precast concrete hollow plank units in accordance with manufacturer's printed instructions and recommendations, and approved Shop Drawings, the Contract Documents, and Laws and Regulations.
2. Keep precast concrete plank units tight and perpendicular to bearing supports.
3. Do not install hollow plank units until supporting members are in place and secured or have obtained their required design strength. When units rest on masonry block, ensure that voids in lintels and bond beams are filled with grout.
4. Comply with erection procedures and sequence of erection as recommended by precast concrete hollow plank unit manufacturer and as acceptable to Engineer.

B. Level and Alignment:
1. Level precast concrete planks accurately or set to uniform slope as shown.
2. Use bearing pads where precast concrete plank units bear on masonry or concrete surfaces. Set planks on solid, level bearings, with bearing surface of precast concrete plank units not less than three inches at steel supports and not less than 3.5 inches at other supports, unless otherwise acceptable to Engineer.
3. Align and level to tolerance in accordance with PCI MNL 135 by methods, procedures, and equipment as recommended by precast concrete hollow plank unit manufacturer.
4. Where adjacent precast concrete plank units are not in vertical alignment due to camber or other reason, level out variations between adjacent members by jacking, loading, or other feasible method as recommended by precast concrete planks manufacturer and professional engineer, and acceptable to Engineer.

C. Do not cut holes or install sleeves larger than size permitted by hollow plank unit manufacturer for pipe, conduits, duct or other penetrations after fabrication, except as otherwise shown or specified.

D. Do not cut reinforcing or prestressing strands without approval of manufacturer and Engineer.

E. Cast-in openings larger than eight inches in any dimension. Do not drill or cut openings or prestressing strand without approval of both the design professional engineer and Engineer.

F. Weld inserts and connections in precast concrete plank units, as shown and specified.

G. Grouting Joints:
1. Clean joints before grouting.
2. Fill joints between units with grout.
3. Before grout hardens, remove grout that seeped through to ceiling below.

H. Clean exposed surfaces of precast concrete hollow plank units after erection and completion of joint treatment, by removing weld marks, dirt and stains, and deleterious materials that could affect the bonding of the topping grout. Perform cleaning in accordance with precast concrete hollow plank units manufacturer's recommendations. Protect other work from staining and damage.

I. Provide topping grout in accordance with Section 03 6000, Grouting, in locations where slab is shown or specified to receive a topping grout.

J. Repair of Damaged Planks: Prior to repairing, submit and obtain Engineer's approval of proposed repair procedures. Submitted repair shall include approval from the professional engineer who

designed the precast concrete plank system and corresponding information or calculations required to substantiate the repair procedures.

END OF SECTION 03 4113

SECTION 03 6000

GROUTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install grout and perform grouting Work.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before grouting Work.

C. Related Sections:
1. Section 03 1500, Concrete Accessories.
2. Section 03 3000, Cast-In-Place Concrete.

D. Application and Grout Material:
1. The following is a listing of grouting applications and the corresponding type of grout material to be provided for the associated application. Unless shown or indicated otherwise in the Contract Documents, provide grout in accordance with the following:

TABLE 03 6000-A, GROUT APPLICATIONS AND MATERIAL TYPES

Application	Required Grout Material Type
Beam and column (one- or two-story height) base plates and precast concrete bearing less than 16 inches in the least dimension	Class II Non-Shrink
Column base plates and precast concrete bearing (greater than two-story height or larger than 16 inches in the least dimension)	Class I Non-Shrink
Base plates for storage tanks and other non-motorized equipment, and motorized equipment or machinery less than 50 horsepower	Class I Non-Shrink (unless otherwise recommended by equipment manufacturer)
Motorized equipment or machinery equal to and greater than 50 horsepower, and motorized equipment or machinery equipment less than 50 horsepower subject to severe shock loads or high vibration	Class III Non-Shrink Epoxy (unless otherwise recommended by equipment manufacturer)
Filling blockout spaces for embedded items	Class II Non-Shrink (Class I where placement time exceeds 15 minutes)

Application	Required Grout Material Type
Grout fill or grout toppings less than four inches thick	Grout Fill
Grout fill greater than four inches thick	Class "B" Concrete in accordance with Section 03 3000, Cast-In-Place Concrete
Applications not listed above, where grout is indicated on the Drawings	Class I Non-Shrink, unless shown or indicated otherwise

1.2 REFERENCES

A. Standards referenced in this Section are:
1. ACI 211.1, Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. ACI 301, Structural Concrete for Buildings.
3. ASTM C33/C33M, Specification for Concrete Aggregates.
4. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
5. ASTM C230/C230M, Specification for Flow Table for Use in Tests of Hydraulic Cement.
6. ASTM C531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
7. ASTM C579, Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
8. ASTM C827, Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
9. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
10. ASTM C939, Text Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
11. ASTM C1107/C1107M, Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
12. ASTM C1181, Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
13. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Grout Testing Laboratory:
   a. Independent testing laboratory employed for design and testing of grout materials and mixes shall comply with testing laboratory requirements in Section 03 3000, Cast-in-Place Concrete and other applicable requirements in the Contract Documents.
2. Manufacturer: Shall have a minimum of five years' experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
3. Manufacturer's Field Service Technician: When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the

products required, with at least five years of experience in field applications of the products required.

B. Trial Batch:
   1. Each grout fill and construction joint grout mix proportion and design shall be verified by laboratory trial batch or field experience methods. Comply with ACI 211.1 and submit to Engineer a report with the following data:
      a. Complete identification of aggregate source of supply.
      b. Tests of aggregates for compliance with specified requirements.
      c. Scale weight of each aggregate.
      d. Absorbed water in each aggregate.
      e. Brand, type, and composition of cement.
      f. Brand, type, and amount of each admixture.
      g. Amounts of water used in trial mixes.
      h. Proportions of each material per cubic yard.
      i. Unit weight and yield per cubic yard of trial mixtures.
      j. Measured slump.
      k. Measured air content.
      l. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven-day and 28-day test, and for each design mix.
   2. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301.
   3. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of Project-specific grout applications, installation locations, and the grout type proposed for each.
      b. List of grout materials and proportions for the proposed mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until submittal is approved by Engineer.
      c. Trial Batch Reports: Submit laboratory test reports for grout materials and mix design tests.
   2. Product Data:
      a. Data sheets, certifications, and manufacturer's specifications for all materials proposed for use.

B. Informational Submittals: Submit the following:
   1. Manufacturer’s Instructions:
      a. Special instructions for shipping, storing, protecting, and handling.
      b. Installation instructions for the materials.
   2. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier’s field service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   3. Qualifications Statements:
      a. Testing laboratory, when not submitted under other Sections.

b. Manufacturer, when submittal of qualifications is required by Engineer.
c. Manufacturer's field service technician, when submittal of qualifications is required by Engineer.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials: Store grout materials in a dry location, protected from weather and protected from moisture.

PART 2 - PRODUCTS

2.1 GENERAL

A. All grout materials, admixtures, cementitious materials, and other materials used in grout that contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

2.2 NON-SHRINK GROUT MATERIALS

A. General: Non-shrink grout shall be a prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or container in which the materials are packaged. Specific formulation for each type or class of non-shrink grout specified in this Section shall be that recommended by the grout manufacturer for the particular application.

B. Class I Non-Shrink Grout:
1. Class I non-shrink grouts shall have a minimum 28-day compressive strength of 7,000 psi. Use grout for precision grouting and where water-tightness and non-shrink reliability in both plastic and hardened states is critical, in accordance with Table 03 6000-A in this Section.
2. Products and Manufacturer: Provide one of the following:
   a. MasterFlow 928, by BASF, Inc.
   b. Five Star Grout, by Five Star Products, Inc.
   c. Hi-Flow Grout, by Euclid Chemical Company.
   d. Or equal.
3. Comply with ASTM C1107/C1107M, Grade C and B (as modified below) when tested using amount of water required to achieve the following properties:
   a. Fluid consistency (20 to 30 seconds) shall be in accordance with ASTM C939.
   b. At temperatures of 45, 73.4, and 95 degrees F.
4. Length change from placing to time of final set shall not have shrinkage greater than the expansion measured at three or fourteen days. Expansion at three or fourteen days shall not exceed the 28-day expansion.
5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.
6. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

C. Class II Non-Shrink Grout:
1. Class II non-shrink grouts shall have minimum 28-day compressive strength of 7,000 psi. Use grout for general-purpose grouting applications in accordance with Table 03 6000-A in this Section.
2. Products and Manufacturer: Provide one of the following:
   a. MasterFlow 100, by BASF, Inc.

b. EZ-Cure Contractor's Grout, by Five Star Products, Inc.
c. NS Grout, by Euclid Chemical Company.
d. Or equal.

3. Comply with ASTM C1107/C1107M and the following when tested using the quantity of water required to achieve the following properties:
   a. Flowable consistency (140 percent flow in accordance with ASTM C230/C230M, five drops in 30 seconds).
   b. Fluid working time of at least 15 minutes.
   c. Flowable for at least 30 minutes.
4. When tested, grout shall not bleed at maximum allowed water.
5. Non-shrink property shall not be based on chemically-generated gas or gypsum expansion.

D. Class III Non-Shrink Epoxy Grout:
1. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.
2. Products and Manufacturer: Provide one of the following:
   a. E3 Flowable, by Euclid Chemical Company.
   b. Sikadur 42 Grout Pak, by Sika Corporation.
   c. HP Epoxy Grout, by Five Star Products, Inc.
   d. Or equal.
3. Epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all pre-measured and prepackaged. Resin component shall not contain non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are unacceptable. Variation of component ratios is not allowed without specific recommendation by manufacturer. Manufacturer's instructions shall be printed on each container in which products are packaged.
4. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
   a. Vertical volume change at all times before hardening shall be between zero percent shrinkage and 4.0 percent expansion when measured in accordance with ASTM C827 (modified for epoxy grouts by using an indicator ball with specific gravity between 0.9 and 1.1).
   b. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
   c. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
   d. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
   e. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
   f. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.
   g. Minimum effective bearing area shall be 95 percent.

2.3 GROUT MATERIALS OTHER THAN NON-SHRINK GROUT

A. General: Materials for grouts (other than non-shrink grouts) shall be in accordance with Section 03 3000, Cast-In-Place Concrete, except as otherwise specified in this Section.

B. Grout Fill:

1. Grout fill shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
    a. Minimum Compressive Strength: 4,000 psi at 28 days.
    b. Maximum Water-Cement Ratio: 0.45 by weight.
    c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
    d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
    e. Air Content: Seven percent (plus or minus one percent).
    f. Minimum Cement Content: 564 pounds per cubic yard.
    g. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed four inches.

C. Construction Joint Grout:
1. Construction joint grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned with similar cementitious characteristics as Class "A" concrete specified in Section 03 3000, Cast-In-Place Concrete. Mix design shall result in grout that is flowable with high mortar content. Mix requirements are:
    a. Minimum Compressive Strength: 4,500 psi at 28 days.
    b. Maximum Water-Cement Ratio: 0.42 by weight.
    c. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
    d. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
    e. Air Content: Seven percent (plus or minus one percent).
    f. Minimum Cement Content: 752 pounds per cubic yard.
    g. Slump for Construction Joint Grout: Seven inches (plus or minute one inch).

2.4 CURING MATERIALS

A. Curing materials shall comply with Section 03 3000, Cast-in-Place Concrete, and shall be as recommended by the manufacturer of prepackaged grouts.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which grouting will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
1. Place grout as shown and indicated, and in accordance with Laws and Regulations and grout manufacturer's instructions. If manufacturer's instructions conflict with the Contract Documents, obtain clarification or interpretation from Engineer before proceeding.
2. Consistency of non-shrink grouts shall be as required to completely fill the space to be grouted for the particular application. Do not install grout for dry-packing without approval of Engineer. When dry-packing is approved by Engineer, dry-pack consistency shall be such that grout has sufficient water to ensure hydration and grout strength development, and remains plastic, moldable, and that does not flow.

3. Grouting shall comply with temperature and weather limitations in Section 03 3000, Cast-In-Place Concrete.
4. Cure grout in accordance with grout manufacturer's instructions for prepackaged grout and Section 03 3000, Cast-In-Place Concrete, for grout fill.

B. Columns and Beams:
1. After shimming columns and beams to proper elevation, securely tighten anchors. Properly form around base plates allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of base plate and top of concrete base to assure that void is completely filled with non-shrink grout.

C. Equipment Bases:
1. Install equipment in accordance to manufacturer's recommendations, Laws, and Regulations, and the Contract Documents. After shimming equipment to proper elevation, securely tighten anchors. Properly form around base plates, allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of equipment base and top of concrete base to ensure that voids are completely filled with non-shrink grout.

D. Construction Joints:
1. Place a six-inch minimum thick layer of construction joint grout over contact surface of concrete at interface of horizontal construction joints in accordance with Section 03 1500, Concrete Accessories, and Section 03 3000, Cast-In-Place Concrete.

E. Grout Fill:
1. All mechanical, electrical, and finish work shall be completed prior to placing grout fill. Base slab shall be provided with a scratched finish in accordance with Section 03 3000, Cast-In-Place Concrete. Roughen existing slabs shall by abrasive blasting or hydroblasting exposing aggregates to ensure bonding to base slab.
2. Minimum thickness of grout fill shall be one-inch. Where finished surface of grout fill is to form an intersecting angle of less than 45 degrees with concrete surface against which grout will be placed, form a key in the concrete surface at the intersection point. Key shall be minimum of 3.5 inches wide by 1.5 inches deep.
3. Thoroughly clean and wet base slab prior to placing grout fill. Do not place grout fill until slab is completely free of standing water. A thin coat of neat Type II cement slurry shall be broomed into surface of slab. Place grout fill while slurry is wet. Grout fill shall be compacted by rolling or tamping, brought to elevation, and floated. In tanks and basins where scraping-type equipment will be installed, grout fill shall be screeded by blades attached to revolving mechanism of equipment in accordance with procedures recommended by equipment manufacturer after grout is brought to elevation.
4. Grout fill placed on sloping slabs shall be installed uniformly from bottom of slab to top, for full width of placement.
5. Test grout fill surface with a straight edge to detect high and low spots; immediately correct high and low spots in grout fill. When grout fill has hardened sufficiently, grout fill shall be steel troweled to provide a smooth surface free of bug holes and other imperfections. While an acceptable type of mechanical trowel may be used in this operation, the last pass over the grout fill surface shall be by hand-troweling. During finishing, do not apply the following to the grout fill surface: water, dry cement, or mixture of dry cement and sand.
6. Cure and protect grout fill in accordance with Section 03 3000, Cast-In-Place Concrete.

3.3 FIELD QUALITY CONTROL

A. Field Testing Services:
   1. Owner will employ testing laboratory to perform field quality control testing for grout. Engineer will direct the testing requirements.
   2. Contractor shall provide all curing and necessary cube storage as specified in Section 01 4528, On-Site Facilities for Testing Laboratory.

B. Quality Control Testing During Construction:
   1. Grout Fill: Perform sampling and testing for field quality control during grout fill placing as follows:
      a. Sampling Fresh Grout Fill: ASTM C172.
      b. Slump: ASTM C143; one test for each load of grout at point of discharge.
      c. Air Content: ASTM C231; one sample for every two grout loads at point of discharge, and when a change in the grout is observed.
      d. Compression Test Specimens:
         1) In accordance with ASTM C109/C109M; make one set of compression cubes for each 50 cubic yards of grout, or fraction thereof, of each mix design placed each day. Each set shall be four standard cubes, unless otherwise directed by Engineer.
   2. Non-shrink Grout: Perform sampling and testing for field quality control during non-shrink grout placing as follows:
      a. Perform compression testing of non-shrink grout in accordance to ASTM C109/C109M at intervals during construction as selected by Engineer. Make a set of four specimens for testing compressive strength at a period of time selected by the Engineer.
      b. Perform compression tests on epoxy grout and fabricate specimens for epoxy grout testing in accordance with ASTM C579, Method B, at intervals during construction as selected by the Engineer. Make a set of four specimens for testing compressive strength at a period of time selected by Engineer.

C. Evaluation of Field Quality Control Tests:
   1. Do not use grout, delivered to final point of placement, having slump or total air content that does not comply with the Contract Documents.
   2. Compressive strength tests for laboratory-cured cubes will be acceptable if averages of all sets of three consecutive compressive strength test results equal or exceed the required 28-day design compressive strength of the associated type of grout.
   3. If the compressive strength tests do not comply with the requirements in the Contract Documents, the grout represented by such tests will be considered defective and shall be removed and replaced, or subject to other action required by Engineer, at Contractor's expense.

D. Manufacturer's Services:
   1. Manufacturers of proprietary materials shall make available upon 72 hours notification the services of qualified, full time employee, experienced in serving as a field service technician for the products required, to aid in assuring proper use of products under the actual conditions at the Site.

END OF SECTION 03 6000

SECTION 04 0505

UNIT MASONRY CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all unit masonry construction. The Work also includes:
      a. Providing openings in unit masonry construction to accommodate the Work under this and other Sections and building into unit masonry construction all items such as sleeves, anchorage devices, inserts, and other items to be embedded in unit masonry construction for which placement is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items to be installed with or before unit masonry construction Work.
   2. Remove and rebuild unit masonry construction advanced without built-in flashings and other built-in items at no additional cost to Owner, even after unit masonry construction has been completed.

C. Related Sections:
   1. Section 04 0511, Masonry Mortaring and Grouting.
   2. Section 04 0519, Masonry Anchorage and Reinforcing.
   3. Section 05 5013, Miscellaneous Metal Fabrications.
   4. Section 06 1053, Miscellaneous Rough Carpentry.
   5. Section 07 1113, Bituminous Dampproofing.
   6. Section 07 2105, Building Insulation.
   7. Section 07 6200, Sheet Metal Flashing and Trim.
   8. Section 07 9200, Joint Sealants.
   9. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 530, Building Code Requirements for Masonry Structures.
   2. ACI 530.1, Specification for Masonry Structures.
   3. ASTM C67, Test Methods for Sampling and Testing Brick and Structural Clay Tile.
   4. ASTM C140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   5. ASTM C387, Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   6. ASTM C780, Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit~~y~~ Masonry.
   7. ASTM C1091, Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines.
   8. ASTM C1093, Practice for Accreditation of Testing Agencies for Unit Masonry.

9. ASTM C1314, Test Method for Compressive Strength of Masonry Prisms.
10. BIA, Technical Notes on Brick Construction.
11. NCMA, TEK Manual for Concrete Masonry Design and Construction.
12. UL, Design No. U 902, Bearing Wall Rating – 4 HR., Alternative Detail.
13. UL, Design No. U 904, Bearing Wall Rating – 3 HR.; Non-bearing Wall Rating – 3 HR.
14. UL, Design No. U 905, Bearing Wall Rating – 2 HR.; Non-bearing Wall Rating – 2 HR.
15. UL, Design No. U 906, Bearing Wall Rating – 2 HR.; Non-bearing Wall Rating – 2 HR.
16. UL, Design No. U 907, Nonbearing Wall Rating – 3 or 4 HR.
17. UL, Design No. U 909, Nonbearing Wall Rating – 3 or 4 HR.
18. UL, Design No. U 912, Bearing Wall Rating – 3 HR.; Non-bearing Wall Rating – 3 HR.
19. UL, Design No. U 913, Bearing Wall Rating – 2 HR.; Non-bearing Wall Rating – 2 HR.
20. UL, Design No. U 914, Bearing Wall Rating – 3 HR.; Non-bearing Wall Rating – 3 HR.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "Masonry control joint" is a joint in interior and exterior masonry walls that allows expansion and contraction to occur independently without damage to the masonry.
   2. "Masonry expansion joint" is a control joint in interior and exterior masonry walls, located at the separation between adjoining parts of a concrete or steel structure that is provided to allow movements transferred to the masonry to occur independently without damage to the masonry.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Engage a single installer regularly engaged in preformed unit masonry installation and with successful and documented experience in erecting unit masonry of the scope and type of Work required; and who employs only tradesmen with specific skill and successful experience in the type of Work required. Submit name and qualifications with the following information for a minimum of three successful projects:
      b. Names and telephone numbers of owners, architects, or engineers responsible for projects.
         1) Approximate contract cost of unit masonry.
         2) Quantity (area) of unit masonry installed.
   2. Testing Laboratory:
      a. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. Employ different laboratories for design of concrete mixes and field testing, in accordance with ASTM C1093.

B. Component Supply and Compatibility:
   1. Obtain each type of concrete masonry units from one manufacturer, cured by one process and of uniform texture and color or in an established uniform blend thereof.
   2. Use a single source and brand of mortar materials throughout the Work.

C. Regulatory Requirements:

1. Where fire-resistance classification is shown or indicated (e.g., four-hour rating, three-hour rating, and similar designations) for unit masonry construction, comply with applicable requirements for materials and installation established by UL tests referenced in this Section and requirements of authorities having jurisdiction.

D. Job Mock-up:
   1. Prior to installing unit masonry and after Engineer's approval of Samples, erect job mock-ups using materials, pattern bond, and joint tooling shown or specified. Build mock-up at the Site, at location acceptable by Engineer, of full required wall thickness. Mock-up shall be approximately four feet by 3.33 feet unless another size or location is shown or indicated for the job mock-up. Provide special features as directed, including finished opening 16 inches by 16 inches, finished end, and masonry control joint. Indicate proposed range of color, texture, and workmanship to be expected in the completed Work. Obtain Engineer's approval of visual qualities of mock-up before starting unit masonry construction. Retain and protect mock-up during construction as a standard for judging unit masonry Work. Do not alter, move, or destroy mock-up until given permission by Engineer.
   2. Build as many mock-up panels as required to obtain Engineer's approval.
   3. Masonry construction that does not comply with standards approved on mock-up panel shall be removed and rebuilt to conform to the Contract Documents. Provide mock-up panel for the following:
      a. Typical complete exterior walls, including metal cavity wall flashing, anchors and masonry wall ties, and other components of complete exterior wall system.
      b. Typical complete interior partition of concrete unit masonry where both sides will remain visually exposed upon completion of the Work.
      c. Typical interior partition of concrete unit masonry using all shapes and accessories shown or indicated on the approved Shop Drawings and other submittals.

E. Pre-Construction Masonry Conference:
   1. Prior to installing unit masonry construction, Contractor and Contractor's installer shall attend pre-construction masonry conference at the Site. Review foreseeable methods and procedures related to unit masonry construction including, but not limited to, the following:
      a. Requirements of the Contract Documents.
      b. Structural concept.
      c. Sequence of masonry construction.
      d. Special masonry details.
      e. Standard of workmanship.
      f. Prism and grout sampling, and unit masonry test results.
      g. Quality control requirements.
      h. Project organization and availability of materials, tradesmen, equipment, and facilities required to avoid delays.
      i. Masonry control and expansion joint locations and materials.
      j. Modular planning requirements.
      k. Weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
      l. Required inspection, testing, and certifying procedures.
      m. Requirements for complying with building codes.
   2. Attendance at the conference is mandatory for the following:
      a. Masonry Subcontractor's superintendent and foreman.
      b. Authorized representative of face brick and concrete unit masonry Suppliers.
      c. Engineer

d. Resident Project Representative, if any.
e. Coordinating Special Inspector.

3. If additional information is required to adequately cover items on agenda, reconvene conference as soon as possible.
4. Contractor shall record discussions of conference and decisions and agreements (or disagreements) and furnish a copy of the record to each person and entity attending.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Complete layout of all masonry walls showing modular planning and all special shapes to be used in the Work. Show all details for each condition encountered in the Work. Submit plan and elevation views drawn at scale of 1/4-inch equal to one foot, and details drawn at scale of 1.5-inch equal to one foot. Show all items included in the unit masonry construction.
b. Masonry control joint locations and details.
c. Drawings showing location, extent, and accurate configuration and profile of all items required by the Contract Documents, in this and other Sections, for unit masonry construction. Provide elevations drawn at scale of 1/4-inch equal to one foot, and details drawn at scale of 1.5-inch equal to one foot.
d. Drawings for fabricating, bending, and placing of reinforcing bars. Submit bar schedules, diagrams of bent bars, stirrup spacing, lateral ties, and other arrangements and assemblies required for fabricating and placing of reinforcing for unit masonry construction.
e. Job Mock-Up: Shop Drawings showing location, extent, and accurate configuration of items to be built-in to mock-ups. Provide elevations drawn at scale of 1.5-inch equal to one foot.
2. Samples:
a. Mock-ups.

B. Informational Submittals: Submit the following:
1. Field Quality Control Submittals:
a. Pre-installation test results in accordance with ASTM C140 and ASTM C1314, and the field quality control Article of this Section.
b. Post-installation quality control submittals in accordance with the field quality control Article of this Section.
2. Qualifications Statements:
a. Installer.
b. Testing laboratory.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
a. Comply with Section 01 7700, Closeout Procedures.
b. Indication location of all masonry control joints and expansion joints.

1.6 DELIVERY, STORAGE AND HANDLING

A. General:
1. Comply with:
a. Section 01 6000, Product Delivery Requirements.

b. Section 01 6000, Product Storage and Handling Requirements.

2. Storage: Maintain temperatures in shelter so that masonry materials are above 20 degrees F when installed.

1.7 SITE CONDITIONS

A. Environmental Requirements:

1. General:
   a. Temporary Facilities and Temporary Utilities: Provide supplemental heat sources and energy as required for unit masonry construction in cold weather.
   b. Do not perform unit masonry construction when air temperature is below 28 degrees F for rising temperature, or below 36 degrees F for falling temperatures, without providing temporary enclosures and heat, or without heating materials or other measures necessary to prevent freezing as specified.
   c. Do not use frozen materials and do not build on frozen unit masonry construction.
   d. Remove and replace all unit masonry construction damaged by cold temperatures and freezing.
2. Protection:
   a. Cold Weather Protection: Protect unit masonry construction against freezing for at least 48 hours after placement, as follows:
      1) When anticipated minimum temperature will be between 40 degrees F and 25 degrees F, cover newly constructed masonry with weather-resistive membrane for 48 hours after installation.
      2) When anticipated minimum temperature will be between 25 degrees F and 20 degrees F, completely cover newly constructed masonry with weather-resistive insulating blankets, or equal protection, for 48 hours after installation.
      3) When anticipated minimum temperature will be below 20 degrees F, maintain newly constructed masonry at temperature above 32 degrees F for at least 48 hours after installation by using heated enclosures, electric heating blankets, infrared lamps, or other acceptable methods of supplementary heating.
   b. Hot Weather Protection: When mean daily temperature exceeds 100 degrees F, or exceeds 90 degrees F with wind velocity greater than eight miles per hour, fog-spray newly constructed masonry until damp at least three times per day until masonry is 72 hours old.
   c. When Work is not in progress, protect partially-completed unit masonry construction against rapid heat loss and from water entering the masonry by covering top of walls with strong, waterproof, non-staining membrane. Extend membrane at least two feet down both sides of wall and secure in place using wall cover clamps spaced at intervals of four feet and at each end, and at joints in the membrane.
   d. Do not apply floor or roof loading for at least 72 hours after completing masonry columns or walls.
   e. Do not apply concentrated loads for at least 168 hours after completing masonry columns or walls.
3. Cold Weather Unit Masonry Construction:
   a. When mean daily temperature is below 40 degrees F, mortar used in unit masonry construction shall be portland cement-lime-sand mortar using high-early strength portland cement. Use mortar within 1.5 hours of initial mixing. Use grout within 1.5 hours of initial mixing.
   b. Clay or shale unit masonry with suctions in excess of 20 grams of water per 30 square inches per minute shall be sprinkled with heated water just prior to installation. Provide water temperature above 70 degrees F when temperature of

masonry units is above 32 degrees F. Water temperature shall be above 120 degrees F when temperature of masonry units is below 32 degrees F.

c. For Air Temperatures of 40 degrees F to 32 degrees F: Water and aggregates used in mortar and grout shall not be heated above 140 degrees F. Heat mortar sand or mixing water to produce mortar temperatures between 40 degrees F and 120 degrees F at time of mixing. Heat water and aggregates for grout when water or aggregate temperature is below 32 degrees F.

d. For Air Temperatures of 32 degrees F to 25 degrees F: Comply with Paragraph 1.7.A.3.c of this Section and the following: Maintain mortar temperature above freezing until used in masonry. Heat aggregates and mixing water for grout to produce grout temperature between 70 degrees F and 120 degrees F at time of mixing. Maintain grout temperature above 70 degrees F at time of grout placement.

e. For Air Temperatures of 25 degrees F to 20 degrees F: Comply with Paragraphs 1.7.A.3.c and 1.7.A.3.d of this Section and the following: Heat masonry surfaces under construction to 40 degrees F. Provide temporary wind breaks or enclosures when wind velocity exceeds 15 miles per hour. Prior to grouting, heat the masonry to minimum of 40 degrees F.

f. For Air Temperatures of 20 degrees F and Below: Comply with Paragraphs 1.7.A.3.c, 1.7.A.3.d, and 1.7.A.3.e of this Section and the following: Provide temporary enclosures and auxiliary heat to maintain air temperature within temporary enclosure above 32 degrees F. Temperature of masonry units when laid shall not be less than 20 degrees F.

4. Hot Weather Unit Masonry Construction: Using methods acceptable to Engineer, protect unit masonry construction from direct exposure to wind and sun when ambient air temperature is 99 degrees F in shade with relative humidity less than 50 percent.

a. When ambient temperature exceeds 100 degrees F, or exceeds 90 degrees F with wind velocity greater than eight miles per hour, maintain temperature of mortar and grout below 120 degrees F. Flush mixers, mortar transport containers, and mortarboards with cool water before they come into contact with mortar ingredients or mortar. Maintain mortar consistency by re-tempering with cool water. Use mortar within two hours of initial mixing. Use grout within 1.5 hours of initial mixing. Maintain sand piles in damp, loose condition.

b. When ambient temperature exceeds 115 degrees F, or exceeds 105 degrees F with wind velocity greater than eight miles per hour, comply with Paragraph 1.7.A.4.a of this Section and the following: Use cool mixing water for mortar and grout. Use of ice will be allowed in mixing water prior to use; ice is not allowed in the mixing water when added to other mortar or grout materials. Shade materials and mixing equipment from exposure to direct sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material requirements for masonry materials are in the following:
1. Section 04 0519, Masonry Anchorage and Reinforcing.
2. Section 04 2200, Concrete Unit Masonry.

B. Mortar, General:
1. Where question of compliance with or interpretation of requirements of this Section arises, mortar properties Specification will take precedence over mortar proportion Specifications.

2. Make no change in proportions established for mortar approved under property Specifications, and do not use materials with different physical characteristics in mortar unless compliance with requirements of property Specifications is re-established by Shop Drawing or submittal data.
3. Do not combine two air-entraining materials in mortar.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which unit masonry construction will be installed, and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Wetting of Masonry Units:
1. Concrete Masonry Units: Except for absorbent units specified to be wetted, lay masonry units dry. Do not wet concrete masonry units.

B. Cleaning of Reinforcing: Before placing, remove loose rust, mill scale, earth, ice, and other contamination from reinforcing materials. Do not use reinforcing bars with kinks or bends not shown or approved Shop Drawings, or bars with reduced cross-section due to rusting or other causes.

3.3 INSTALLATION, GENERAL

A. Thickness: Build walls, floors, and other unit masonry construction to thickness shown or indicated. Build single wythe walls to actual thickness of masonry units using units of nominal thickness shown or indicated.

B. Build chases and recesses as shown or required by others, as specified. Provide not less than eight inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

C. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to starting unit masonry construction. After installation of said items, complete unit masonry construction to match the Work immediately adjacent to openings.

D. Cut masonry units using motor-driven wet cutting saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full-size units without cutting where possible. Provide special unit masonry shapes for transitions and intersections. Do not attempt to field-cut special shapes from regular unit masonry shapes, and do not use other options for special unit masonry shapes.

E. Build interior masonry walls visible from both sides in the finished Work using two wythes of masonry. Masonry shall be continuous over entire plane of wall, including walls that continue behind fixtures, equipment, furniture, lockers, and similar items

F. Matching Existing Masonry: Match with existing masonry the coursing, pattern bond, color, and texture of new unit masonry construction

3.4 LAYING MASONRY WALLS

A. General:
1. Mortar Types: Unless otherwise shown or indicated, use mortar specified in Section 04 0511, Mortar and Masonry Grout, as follows:
   a. Use Type S mortar for all exterior and interior load-bearing and non load-bearing walls.
   b. Use grout fill for structural requirements and for grouting reinforcing steel in unit masonry construction.
   c. Do not use mortar that has begun to set or if more than thirty minutes have elapsed since initial mixing. Re-temper mortar during the thirty-minute period only as required to restore workability.
2. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns, and offsets. Avoid using less than half-size units at corners, jambs, and where possible at other locations.
3. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced, and coordinated with other work.
4. Pattern Bond:
   a. Lay all concrete unit masonry in running bond pattern with vertical joints in each course centered on units in courses above and below. Avoid using less than full-size units.
   b. Lay concrete unit masonry scheduled or shown to be concealed by finish materials, except paint, with units in wythe bonded by lapping not less than two inches.
   c. Bond and interlock each course of each wythe at corners.
   d. Do not use units with less than four-inch horizontal face dimensions at corners or jambs.
5. Color and Texture:
   a. Lay concrete unit masonry using mortar of natural color.

B. Construction Tolerances:
1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 1/4-inch in ten feet, or 3/8-inch in a story height (20 feet), maximum, nor 1/2-inch in 40 feet or more. Except for external corners, expansion joints and other conspicuous lines, do not exceed 1/4-inch in any story or 20 feet maximum, nor 1/2-inch in 40 feet or more.
2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
3. Variation of Linear Building Line: For position shown and related portion of columns, walls and partitions, do not exceed 1/2-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
4. Variation in Cross Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4-inch nor plus 1/2-inch.

C. Mortar Bedding and Jointing:
1. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course of piers, columns, and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
2. Maintain joint widths shown, except for minor variations required to maintain pattern bond alignment. If not shown, lay unit masonry to provide the following joint widths:
   a. Concrete Unit Masonry: 3/8-inch.
   b. Concrete Unit Masonry Patches: Match existing adjacent joint width.

3. Cut joints flush for masonry walls to be concealed or to be covered by other materials, except paint, unless otherwise shown.
4. Tool exposed joints slightly concave, when mortar is "thumbprint hard", unless otherwise required to match existing joint treatment. Rake out mortar 1/2-inch deep in preparation for application of calking or sealants and for epoxy pointing mortar for glazed structural tile where required.
5. Concave-tool exterior joints below grade.
6. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units that have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

D. Collar Joints:
1. Fill vertical space between wythes solidly with mortar by parging the in-place wythe and shoving units into the parging, for the following unit masonry construction:
   a. Exterior multi-wythe walls, except cavity walls, and interior multi-wythe walls and partitions.
   b. Load-bearing interior walls and partitions where metal ties or horizontal reinforcing are specified for structural bonding.
   c. Non-load-bearing interior walls or partitions where metal ties or horizontal reinforcing are specified for structural bonding and full thickness of wall or partition is required to comply with code requirements for thickness to height ratio.

E. Stopping and Resuming Work: Rake back one unit masonry length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, if required, and remove loose masonry units and mortar prior to laying new masonry.

F. Built-in Work:
1. As the Work progresses, build-in the items shown, specified or required in the Contract Documents. Fill cores in one-block width solidly with mortar around built-in items.
2. Do not fill space between hollow metal frames and masonry solidly with mortar.
3. Where built-in items are to be embedded in cores of hollow masonry units, place layer of cavity fill mesh in the joint below and rod mortar or grout into core.
4. Where required by Laws or Regulations, or to comply with thickness-to-height ratio, or to provide required fire resistance, fill all cells of unit masonry construction solid with grout.
5. Use individual metal ties embedded in horizontal joints to bond wythes together Refer to Section 04 0519, Masonry Anchorage and Reinforcing, for type of ties required. Provide ties as shown, but not less than one metal tie for four square feet of wall area spaced not to exceed two feet on centers horizontally and vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than three feet apart around perimeter of openings.
6. Use continuous reinforcing embedded in horizontal mortar joints for bond tie between wythes as specified in this Section.
7. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown or indicated.
   a. For horizontally reinforced masonry, provide continuity at corners with prefabricated "L" units as specified in this Section, in addition to masonry bonding.
8. Intersecting and Abutting Walls: Unless vertical expansion or masonry control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
   a. Provide masonry bond in alternate courses.
   b. Provide individual metal ties at not more than two feet on centers vertically.

c. Provide continuity with horizontal joint reinforcing using prefabricated “T” and “L” units.

G. Non-Load-Bearing Interior Partitions and Non-Load-Bearing Interior Cavity Wall Wythe:
1. Build full height of story to underside of structure above, unless otherwise shown or indicated.
2. Tie non-load-bearing partitions and non-load-bearing interior wythe of cavity walls at top and sides with masonry anchors at terminations. Build in end blocks as shown and specified to facilitate placing compressible filler. Insert compressible filler, specified in Section 04 0519, Masonry Anchorage and Reinforcing, in all horizontal and vertical joints where non-load-bearing masonry and non-load- bearing interior wythe of cavity walls terminate. Insert filler 3/4-inch from both faces of masonry. Use filler four times as thick as widest part of joint. Thickness of filler shall be a minimum of 1.5 times the compressed thickness. Compress filler to less than thickness of joint and insert. At splices, overlap strips by three inches and compress ends to form tight joint. Finish with backer rod and sealant.
3. At terminations of non-load-bearing masonry walls and non-load-bearing interior wythe of cavity walls requiring a fire rating, use fire-safing insulation specified in Section 07 2105, Building Insulation. Build in end blocks to facilitate placing fire-safing insulation. Insert insulation in a continuous, vapor-tight, solid blanket to 3/4-inch from both faces of masonry. Finish with backer rod and sealant.

H. Cavity Walls:
1. Verify that bituminous damproofing is installed; refer to Section 07 1113, Bituminous Dampproofing.
2. Position insulation as shown and in accordance with Section 07 2105, Building Insulation.
3. Install cavity drainage material.
4. Keep cavity clean of mortar droppings during construction by using continuous horizontal board of same width as cavity with lifting wires at each end. Lift board upward before placing horizontal joint reinforcing. Clean mortar droppings from board. Do not clean into cavity. Joints facing cavity shall be struck flush.
5. Tie exterior wythe to back-up with individual metal ties spaced not more than 16 inches on centers vertically and 16 inches on centers horizontally. Stagger in alternate courses.
6. Tie exterior wythe to back-up with rectangular box-tie sections, seismic clips and horizontal continuous wire embedded in mortar joints and anchored in slot created by double looped ties spaced not more than 16 inches on centers vertically and 16 inches on centers horizontally.
7. Tie exterior wythe to back up with continuous horizontal joint reinforcing, embedded in mortar joints at not more than 16 inches on centers vertically. Refer to Section 04 0519, Masonry Anchorage and Reinforcing, for type of reinforcing required.
8. Provide weep holes in exterior wythe of cavity wall located in wall foundation courses and immediately above ledges and flashing, spaced two feet on centers, unless closer spacing is shown or indicated. Install plastic weep tubes. Keep weep holes free of mortar and other obstructions.

I. Horizontal Joint Reinforcing:
1. Provide continuous horizontal joint reinforcing as shown and specified. Refer to Section 04 0519, Masonry Anchorage and Reinforcing, for reinforcing units required. Fully embed longitudinal side rods in mortar for entire length of rods with minimum cover of 5/8-inch on exterior side of walls and 1/2-inch at other locations. Lap reinforcing minimum of six inches at ends of units. Do not bridge masonry control joints and building expansion joints with reinforcing.

2. Reinforce walls with continuous horizontal joint reinforcing unless specifically indicated as being omitted.
3. Provide continuity at corners and wall intersections by using prefabricated “L” and “T” sections. Cut and bend units in accordance with manufacturer’s written instructions for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
4. Space continuous horizontal reinforcing as follows:
    a. For multi-wythe walls, solid or cavity, that are structurally bonded by masonry headers or individual wire ties, space horizontal reinforcing two feet on centers vertically.
    b. For multi-wythe walls, solid or cavity, where continuous horizontal reinforcing also acts as structural bond or tie between wythes, space reinforcing as required by Laws and Regulations, but not more than 16 inches on centers vertically.
    c. For single-wythe walls, space reinforcing at 16 inches on centers vertically, unless otherwise shown.
    d. For parapets, space reinforcing at eight inches on centers vertically, unless otherwise shown.
5. Reinforce masonry openings greater than 12 inches wide, with horizontal joint reinforcing placed in two horizontal joints approximately eight inches apart, immediately above lintel and immediately below sill. Extend reinforcing a minimum of two feet beyond jambs of opening.
6. In addition to wall reinforcing, provide additional reinforcing at openings as required to comply with the above.

J. Structural Reinforced Unit Masonry Construction:
1. Comply with ACI 530, ACI 530.1 and Laws and Regulations for structural reinforced unit masonry construction.
2. Shape and dimension reinforcement as shown and required by applicable ACI standards and Laws and Regulations.
3. Position reinforcing accurately at spacing shown on approved Shop Drawings. Support and secure vertical bars against displacement using rebar positioners.
4. Where vertical bars are shown in close proximity, provide clear distance between bars of not less than the greater of the nominal bar diameter or one-inch.
5. For columns, piers, and pilasters, provide clear distance between vertical bars as shown, but not less than the greater of 1.5 times nominal bar diameter or 1.5 inches. Provide lateral ties.
6. Provide lapped splices with reinforcing steel placed in contact and wire tied. Provide minimum lap required by Laws and Regulations, unless requirements that are more stringent are shown or indicated. Do not splice reinforcing at points other than shown or as approved on Shop Drawings.
7. Provide substantial and tight formwork and shores as required for temporary support of reinforced masonry elements. Design, erect, support, brace, and maintain formwork.
8. Construct formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar grout. Brace, tie, and support as required for maintaining position and shape during construction and curing of reinforced masonry.
9. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and all other temporary loads that may be placed on them during construction.
10. Allow not less than the following duration to elapse after completing a member before removing shores or forms, provided suitable curing conditions have been obtained during the curing period:

a. Girders and Beams: Ten days.
b. Slabs: Seven days.
c. Reinforced Masonry Soffits: Seven days.

K. Grouting Structural Reinforced Unit Masonry Construction:
1. Limit extent of masonry construction to sections that do not exceed the maximum pour requirements specified. Provide temporary dams or barriers to control horizontal flow of grout at ends of wall sections. Build dams to full height of grout pour. If masonry units are used, do not bond into permanent masonry wythes. Remove temporary dams after completing grout pour.
2. Use fine grout for filling spaces less than four inches in both horizontal directions. Use coarse grout for filling spaces four inches or larger in both horizontal directions.
3. For spaces 10 inches and larger, use concrete fill.
4. Low-Lift Grouting:
a. Use low-lift grouting techniques using fine grout mix for the following:
1) Two-wythe walls with grout space of two inches or less in width.
2) Multi-wythe walls.
3) Columns, piers and pilasters where masonry units are shown in core areas enclosed by masonry units.
4) Grout spaces less than 2-inches in width at intervals not to exceed two feet in lifts of six to eight inches.
5) At Contractor's option, low-lift-grouting technique may be used for structural reinforced unit masonry construction with grout spaces wider than two inches, except use coarse grout mix and place in lifts not to exceed eight inches in height.
b. Construct low-lift structural reinforced unit masonry construction by placing reinforcing, laying masonry units and pouring grout as the Work progresses.
c. Place vertical reinforcing bars and supports prior to laying of masonry units. Extend above elevation of maximum pour height as required to allow for splicing. Horizontal reinforcing bars may be placed progressively with laying of masonry units.
d. Limit grout pours as required to prevent displacing masonry by grout pressure (blowout), but do not exceed 12-inch pour height.
e. Lay masonry units prior to each grout pour, but do not construct more than 12 inches above maximum grout pour height in one exterior wythe and four inches above in other exterior wythe. Provide metal wall ties, if required, to prevent blowouts.
f. Pour grout using container with spout and consolidate immediately by rodding or puddling; do not use trowels. Place grout continuously; do not interrupt pouring of grout for more than one hour. If poured in lifts, place from center-to-center of masonry courses. Terminate pour 1.5 inches below top of highest course in pour.
5. High-Lift Grouting:
a. High-lift grouting technique may be used for the following structural reinforced unit masonry construction:
1) Two-wythe walls with grout spaces of 2.5 inches or greater width.
2) Columns, piers, or pilasters when no unit masonry fill is shown to be placed in reinforced grout space.
b. Place reinforcing and support in proper position, prior to laying of masonry units, except if shown to be placed in mortar joints, place as masonry units are laid. Place horizontal bars in grout spaces on same side of vertical bars.
c. Construct high-lift structural reinforced unit masonry construction by laying masonry to full height and width prior to placing of grout. Provide cleanout holes in

first course of masonry, and use high-pressure water jet stream to remove excess mortar from grout spaces, reinforcing bars and top surface of structural members, which support wall. Clean grout spaces daily during construction of masonry.

d. Walls: Omit every other masonry unit in first course of one wythe to provide cleanout holes. Tie wythes together with metal ties as shown or required by Laws and Regulations, but provide not less than nine-gage wire ties spaced not less than two feet on centers horizontally and 16 inches on centers vertically for running pattern bond or 12 inches on centers vertically for stack bond.

e. Columns, Piers, and Pilasters: Omit every other masonry unit around perimeter of member to provide cleanout holes. Provide reinforcing bands placed in bed joints as the structural reinforced unit masonry construction progresses. Provide bands of the size and vertical spacing shown, or as required by Laws and Regulations, but not less than nine-gage wire spaced 12 inches on centers vertically.

f. Preparation of Grout Spaces: Prior to grouting, inspect and clean grout spaces. Remove dirt, dust, mortar droppings, loose pieces of masonry, and other foreign materials from grout spaces. Clean reinforcing and adjust to proper positioning. Clean top surface of structural members supporting masonry to ensure bond. After cleaning and inspection, close cleanout holes with matching masonry units and brace closures to resist grout pressures.

g. Place grout after entire height of masonry to be grouted has attained sufficient strength to resist grout pressure, but not less than three days curing time. Install shores and bracing, if required, before starting grouting operations.

h. Place grout by pumping into grout spaces, unless alternate methods are acceptable to Engineer.

i. Use coarse grout mix. Rod or vibrate each grout lift during placing and again after excess moisture has been absorbed, but before plasticity is lost. Do not penetrate or damage grout placed in previous lifts or pours.

j. Limit grout pours to sections that can be completed in one working day with not more than one-hour interruption of pouring operation. Limit pours to not exceed capacity of masonry to resist displacement or loss of mortar bond due to grout pressures.

   1) Do not exceed 12 feet pour height.
   2) Do not exceed 25 feet horizontal pour dimension.

k. Where pour height exceeds four feet place grout in series of lifts not exceeding four feet in height. Place each lift as continuous pouring operation. Allow at least 30 minutes and not more than 60 minutes between lifts of each pour.

l. When more than one pour is required to complete a section of masonry, extend reinforcing beyond masonry as required for splicing. Pour grout to within 1.5 inches of top course of first pour. After grouted masonry is cured, remove temporary dams, lay masonry units, and place reinforcing for second pour section before grouting.

L. Anchoring Masonry Work:

1. Provide anchoring devices as specified under Section 04 0519, Masonry Anchorage and Reinforcing. If not shown or indicated, provide standard type for facing and back-up involved in compliance with Laws and Regulations.
2. Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:
   a. Provide an open space not less than a 1/2-inch or more than one-inch in width between masonry and structural members, unless otherwise shown. Keep open space free of mortar and other rigid materials.

b. Anchor masonry to cast-in-place concrete and structural steel members with metal ties embedded in masonry joints and attached to structure. Provide anchors with flexible tie sections.
c. Space anchors as shown, but not more than two feet on center vertically and three feet on centers horizontally.
d. Provide end blocks where masonry abuts structural support to facilitate installation of compressible filler, fire-safing insulation, backer rod, and sealant.

3. Anchor single-wythe masonry veneer to backing with metal ties as follows:
a. Anchor veneer to structural members with metal anchors embedded in masonry joints and attached to structure. Provide anchors with flexible tie section, unless otherwise shown.
b. Anchor veneer to concrete back-up with dovetail anchors and to structural steel back-up with slotted anchors.
c. Anchor veneer to concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips with triangular ties, fitted with flexible dovetails for anchorage to cast-in-place concrete, snap-locked to seismic clip and attached to structural supports in accordance with Section 04 0519, Masonry Anchorage and Reinforcing.
d. Space anchors as shown, but not more than two feet on centers vertically and three feet on centers horizontally.

M. Masonry Control and Expansion Joints:
1. Provide vertical expansion and control joints in masonry where shown. Build in related items as unit masonry construction progresses. Rake out mortar in preparation for application of calking and sealants, in accordance with Section 07 9200, Joint Sealants.
2. Provide masonry control and expansion joints items specified under Section 04 0519 and Masonry Anchorage and Reinforcing,
a. Build-in compressible fillers as specified. Install in accordance with manufacturer's written instructions.
b. Build-in factory-premolded control joint strips into masonry. Build-in sash block and premolded control joint strips as the Work progresses.
c. Provide end blocks where masonry partitions abut structure to facilitate installation of compressible filler, fire-safing insulation, backer rod, and sealant.
3. Concrete Unit Masonry Control Joint Spacing: Locate masonry control joints as recommended by NCMA TEK Manual for Concrete Masonry Design and Construction.
4. Masonry Control and Expansion Joint Spacing: Provide masonry control and expansion joints as shown.

N. Lintels and Bond Beams:
1. Provide steel lintels where shown and as specified in Section 05 5013, Miscellaneous Metal Fabrications.
2. Provide masonry lintels and bond beams where shown and where openings of 16-inches or greater are shown without structural steel lintels. Provide formed-in-place masonry lintels and bond beams. Temporarily support formed-in-place lintels and bond beams.
a. Unless otherwise shown or indicated, provide one horizontal No. 4 deformed reinforcing bar for each four inches of wall thickness.
b. For hollow masonry unit walls, use specially formed U-shaped lintel and bond beam units with reinforcing bars placed as shown, filled with grout as specified in Section 04 0511, Masonry Mortaring and Grouting.
3. Provide minimum bearing at each jamb, of four inches for openings less than six feet wide, and eight inches for wider openings.

4. On concrete and clay unit masonry walls where pattern bond remains visually exposed, increase minimum bearing of masonry lintels to maintain joint pattern of wall and install to be indistinguishable from surrounding masonry.

O. Flashing of Masonry Work:
   1. Provide concealed flashings in masonry Work as shown or indicated. Refer to Section 07 6200, Sheet Metal Flashing and Trim, for flashing requirements. Prepare masonry surfaces smooth and free from projections that might puncture flashing. Place through-wall flashing on bed of mortar and cover with mortar. Seal flashing penetrations with mastic before covering with mortar. Terminate flashing 1/2-inch from face of wall, unless otherwise shown or indicated.
      a. Extend flashings beyond edge of lintels and sills at least four inches and turn up edge on sides to form pan to direct moisture to exterior.
      b. Interlock end joints of deformed metal flashings by overlapping deformations not less than 1.5 inches and seal lap with elastic sealant.
      c. For metal through-wall flashing, weld joints watertight.
      d. Install flashings in accordance with manufacturer's instructions and approved Shop Drawings and other submittals.
      e. Provide flexible flashings in accordance with manufacturer's instructions and approved Shop Drawings and other submittals.
   2. Provide weep holes in head joints of first course of masonry immediately above concealed flashings. Spacing is specified elsewhere in this Section.
   3. Install reglets and nailers for flashing and other related Work where shown to be built into unit masonry construction.
   4. Install flexible masonry flashing into cast-in-place elastic masonry flashing reglets with lead wedges and fill reglet with elastic flashing manufacturers recommended bonding rubber-based adhesive cement.

3.5 REPAIR, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or defective, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings, and adjacent Work to provide a neat, uniform appearance, properly prepared for application of sealant compounds.

C. Cleaning Exposed, Unglazed Masonry Surfaces:
   1. Wipe off excess mortar as the Work progresses. Dry-brush at end of each day's work.
   2. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20 square feet as described below. Obtain Engineer's acceptance of sample cleaning before proceeding to clean remainder of masonry Work.
      a. Dry clean to remove large particles of mortar using wood paddles and scrappers. Use chisel or wire brush if required.
      b. Presoak wall by saturating with water and flush off loose mortar and dirt.
      c. Scrub down wall with stiff fiber brush and solution of half-cup of sodium hexameta phosphate and half-cup of household detergent dissolved in one gallon of water.
      d. Rinse walls, using clean, pressurized water, to neutralize cleaning solution and remove loose material.
      e. Acid cleaning of masonry is unacceptable.

D. Protection:
1. Protect the unit masonry construction from deterioration, discoloration, and damage during subsequent construction operations. At areas where items are installed that project from the finish plane of masonry walls, such as concrete curbs, precast concrete sills, and the like, immediately upon completion of the projecting portion of the Work, provide a minimum 3/4-inch thick plywood cover, cut to fit, to prevent damage from operations continuing above the work. Refer to Section 06 1053, Miscellaneous Rough Carpentry.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Pre-construction Testing:
a. Engage independent testing laboratory to obtain samples and conduct the following tests prior to the start of installation of unit masonry construction:
1) Mortar Test: For each mix required: ASTM C780.
2) Grout Test: For each mix required: ASTM C1019 and ACI 530.1.
3) Prism Test: For each type of construction required: ASTM C1314 and ACI 530.1.
4) Compressive strength of completed concrete unit masonry walls shall be at least 1,500 psi as determined by methods in ACI 530.1.
b. Obtain Engineer's acceptance of tests results prior to commencing installation of materials.
c. After initial test, Engineer will require performance of up to five additional tests Engineer's discretion.
2. During and After Installation:
a. Comply with Section 01 4533, Special Inspections.
3. Repair masonry walls that do not comply with requirements of the special inspections in a manner acceptable to Engineer.

END OF SECTION 04 0505

SECTION 04 0511

MASONRY MORTARING AND GROUTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install masonry mortaring and grouting for unit masonry construction.
   2. This Section includes masonry mortaring and grouting for masonry products specified in:
      a. Section 04 2200, Concrete Unit Masonry.
   3. Types of materials required under this Section include:
      a. Portland cement-lime mortars.
      b. Fire-resistant mortars.
      c. Ready-mixed mortar
      d. Fine grout.
      e. Coarse grout.
      f. Grout fill around reinforcement in masonry lintels and bond beams.
      g. Epoxy pointing mortar.
      h. Mortar waterproofing admixtures, inorganic pigments, and other miscellaneous mortar components and additives.

B. Related Sections:
   1. Section 04 0505, Unit Masonry Construction.
   2. Section 04 2200, Concrete Unit Masonry.

1.2 REFERENCES

A. Referenced Standards: Standards referenced in this Section are:
   1. ANSI A108/A118/A136.1, Installation of Ceramic Tile.
   2. ANSI/UL 263, Fire Resistance Ratings.
      a. BXUV U904, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
      b. BXUV U905, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
      c. BXUV U906, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
      d. BXUV U907, Nonbearing Wall Rating – 3 or 4 HR.
      e. BXUV U909, Nonbearing Wall Rating – 3 or 4 HR.
      f. BXUV U912, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
      g. BXUV U913, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
      h. BXUV U914, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
   3. ASTM C5, Specification for Quicklime for Structural Purposes.
   4. ASTM C144, Specification for Aggregate for Masonry Mortar.
   5. ASTM C150/C150M, Specification for Portland Cement.
   6. ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
   7. ASTM C270, Specification for Mortar for Unit Masonry.
   8. ASTM C387/C387M, Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   9. ASTM C404, Specification for Aggregates for Masonry Grout.

10. ASTM C1019, Test Method for Sampling and Testing Grout.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Do not change source or brands of mortar materials during the Project.

B. Regulatory Requirements:
   1. Where fire-resistance classification is shown or indicated for unit masonry construction (four-hour, three-hour, and similar designations), proportion mortar and masonry grouts to comply with requirements established by fire rating designations of ANSI/UL 263 indicated in this Section, Laws and Regulations, and requirements of authorities having jurisdiction.

C. Job Mockup: Refer to Section 04 0505, Unit Masonry Construction.

D. Pre-submittal Meeting:
   1. Before submitting Samples of colored mortar for approval, Contractor and Supplier shall meet at the Site with ENGINEER to review existing mortar to be matched and to preview proposed materials and colors.
   2. Refer to Section 04 0505, Unit Masonry Construction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of locations where each mortar type will be used in the Work.
      b. Grout mix design and material certification.
   2. Product Data:
      a. Manufacturer's specifications and instructions for each manufactured material or product.
      b. Compression test results of grout mix, for identical mix previously prepared and tested, in accordance with ASTM C1019, at maximum aggregate allowed. If no previously-prepared mix is identical, perform tests on the job mix design in accordance with ASTM C1019 and submit to ENGINEER.
      c. Product data and specifications for integral waterproofing admixture.
   3. Samples:
      a. Each type of colored mortar, showing range of color expected in the Work.
      b. Standard and custom colors of epoxy pointing mortar for final selection by ENGINEER.
      c. Label samples to indicate type and quantity of colorant used.
      d. ENGINEER's review will be for color only. Compliance with other requirements is Contractor's responsibility.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement: Provide the following for portland cement-lime mortars:
   1. ASTM C150/C150M:
      a. Use Type I when installation temperature is 50 degrees F or higher.

b. Use Type III, high-early strength, when installation temperature is lower than 50 degrees F.

2. Products and Manufacturers: Provide one of the following:
   a. Type I and Type III Portland Cement, by Essroc Italcementi Group.
   b. Type I and Type III Portland Cement, by Lehigh Portland Cement Company.
   c. White Portland Cement Type I and Type III, by Federal White Cement Ltd.
   d. White Portland Cement Type I and Type III, by Lehigh Portland Cement Company.
   e. Or equal.
3. Provide non-staining portland cement of natural color or of color required to be compatible with required mortar pigment color selected by ENGINEER.

B. Hydrated Lime: ASTM C207, Type S, or lime putty ASTM C5.

C. Sand Aggregates:
1. Mortar Aggregates: ASTM C144, except for joints less than 1/4-inch use aggregate graded with 100 percent passing the No. 16 sieve.
2. Colored Mortar Aggregates: Provide ground marble, granite or other sound stone, as required to match the Sample approved by ENGINEER for portland cement-lime mortars.
3. Fine Aggregate for Grout: ASTM C404, Size No. 1.
4. Coarse Aggregate for Grout: ASTM C404, Size No. 8 or Size No. 89.

D. Colored Mortar Pigments: Provide the following for portland cement-lime mortars:
1. Commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black, compounded for use in mortar mixes.
2. Products and Manufacturers: Provide one of the following:
   a. True-Tone Mortar Colors, by Davis Colors, a Subsidiary of Rockwood Pigments, Inc.
   b. SGS Concentrated Mortar Colors, by Solomon Colors.
   c. Or equal.
3. Do not exceed pigment to cement ratios, by weight, of one-to-35 for carbon black, and one-to-seven for other pigments.
4. Submit complete selection of manufacturer's standard and custom colors for final selection by ENGINEER.

E. Ready-mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified in Article 2.1 of this Section, combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C270 and ASTM C387/C387M.

F. Water: Free of injurious amounts of oils, acids, alkalis, and organic matter, and clean, fresh, and potable.

G. Water-repellent Admixture for Exterior Masonry Mortar:
1. Provide cross-linked acrylic polymer integral waterproofing system.
2. Products and Manufacturers: Provide one of the following:
   a. DRY-BLOCK Mortar Admixture, by Grace Construction Products Division, W. R. Grace & Company.
   b. Eucon Blocktite Mortar Admixture, by Euclid Chemical Company.
   c. Or equal.
3. Proportion: In accordance with manufacturer's instructions.

2.2 MORTAR MIXES

A. General:
   1. Material Performance:
      a. Masonry Strength: Refer to Section 04 0505, Unit Masonry Construction.
      b. If questions of compliance with the Contract Documents arise, Specifications for mortar properties shall take precedence over Specification for mortar proportions.
   2. Do not change proportions established for mortar approved, and do not use materials with different physical characteristics in mortar used in the Work, unless compliance with the Contract Documents for mortar properties is re-established via submittals approved by ENGINEER.
   3. Do not combine in mortar different air-entraining materials.
   4. Anti-freeze Admixture or Agents: Not allowed.
   5. Calcium Chloride: Not allowed.

B. Fire-Resistant Mortar:
   1. Reference Standard: ANSI/UL BXUV U901 through BXUV U914.
   2. Proportion: Use one part portland cement, three parts clean sand, and 15 percent hydrated lime (by cement volume).

C. Mortar for All Unit Masonry: Comply with ASTM C270, Table 2, except limit materials to those specified in this Section. Limit cement-to-lime ratio by volume as follows:
   1. Type S:
      a. Provide the following proportions by volume:
         1) Portland Cement: One part.
         2) Hydrated Lime or Lime Putty: Over 1/4 to 1/2, maximum.
         3) Aggregate Ratio (measured in damp loose condition): Not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
      b. Properties:
         1) Average Compressive Strength, ASTM C270: 1,800 psi.
         2) Minimum Water Retention, ASTM C270: 75 percent.
   2. Maximum Air Content, ASTM C270: 12 percent.

D. Grout:
   1. Fine Grout:
      a. Provide the following proportions by volume:
         1) Portland Cement: One part.
         2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
         3) Aggregate Ratio (measured in a damp loose condition): Sand; not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
      b. Mix grout to have slump of ten inches plus or minus one inch at time of placement.
   2. Coarse Grout:
      a. Provide the following proportions by volume:
         1) Portland Cement: One part.
         2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
         3) Fine Aggregate Ratio (measured in a damp loose condition): Sand; not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
         4) Coarse Aggregate Ratio: Not less than one and not more than two times the sum of volumes of cementitious materials.
      b. Mix grout to have slump of ten inches plus or minus one inch at time of placement.

E. Grout Fill Around Reinforcement in Masonry Lintels: Portland cement, sand, gravel and water, to be proportioned as required to provide 28-day minimum compressive strength of 2,000 psi.

F. Colored Pigmented Cement Mortar: For portland cement-lime mortars proportion pigments with other ingredients as follows:
   1. Mix to match Sample approved by ENGINEER.

G. Colored Aggregate Mortar: For portland cement-lime mortars proportion colored aggregate with other ingredients to match Sample approved by ENGINEER.
   1. Proportion colored aggregate with other ingredients as follows:
   2. Mix to match Sample approved by ENGINEER.

H. Water-repellent Admixture: Add to mix in accordance with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Measurement of Materials:
   1. Cement and Hydrated Lime: Batched by the bag.
   2. Sand: Batched by volume in suitably calibrated containers. Make allowance for bulking and consolidation, and for weight per cubic foot of contained moisture.
   3. Proportion of Volumetric Mixtures: One 94-pound sack of portland cement and one 50-pound sack of hydrated lime constitute nominal one cubic foot.
   4. Shovel measurement: Unacceptable.

B. Mortar Mixing:
   1. Type of Mixer: Machine mix in appropriate mixer in which quantity of water is accurately and uniformly controlled.
   2. While mixer is operating, add approximately three-quarters of required water, half the sand, all the cement, and then add remainder of sand.
   3. Allow batch to mix briefly and then add balance of water in small quantities until satisfactory workability is obtained.
   4. Mix for not less than five minutes after all materials have been added.
   5. Hydrated Lime for Mortar Requiring Lime Content: Use dry-mix method. Turn materials over together for each batch until even color of mixed, dry materials indicates that cementitious material has been thoroughly distributed throughout the mass, and then add water to obtain required plasticity.
   6. Prepare lime putty, if approved for use, in accordance with ASTM C5.
   7. Waterproofing Admixture: Add to mortar mix for all exterior masonry in accordance with manufacturer's instructions.
   8. Mixer drum shall be completely emptied before recharging the next batch.
   9. Limit batch size to avoid re-tempering. Re-tempering of mortar is not allowed.

3.3 INSTALLATION AND MORTAR AND GROUT TYPE LOCATION

A. For mortar and grout type, location, and installation requirements, refer to:
   1. Section 04 0505, Unit Masonry Construction.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. Refer to Section 04 0505, Unit Masonry Construction, for load-bearing masonry wall strength tests.

END OF SECTION 04 0511

SECTION 04 0519

MASONRY ANCHORAGE AND REINFORCING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install masonry anchorages and reinforcing.
   2. Section specifies masonry anchorages and reinforcing for Work specified in:
      a. Section 04 0505, Unit Masonry Construction.
   3. Types of products required include:
      a. Continuous horizontal wire reinforcing and ties.
      b. Individual wire ties.
      c. Anchoring and positioning devices.
      d. Miscellaneous masonry accessories, reinforcing bars, compressible filler, and premolded control joint strips.

B. Coordination:
   1. Provide masonry anchorages and reinforcing of sizes, dimensions and configurations coordinated with unit masonry construction system component sizes, dimensions and configurations.
   2. Where continuous horizontal cavity wall reinforcement is required for restraining cavity wall insulation, coordinate dimensions with specified thickness of cavity wall insulation for proper clearances. Refer to Section 07 2105, Building Insulation.

C. Related Sections:
   1. Section 05 1200, Structural Steel Framing.
   2. Section 07 2105, Building Insulation.
   3. Section 07 6200, Sheet Metal Flashing and Trim.
   4. Section 07 9200, Joint Sealants.
   5. Section 09 9100, Painting.

1.2 REFERENCES

A. Reference Standards: Standards referenced in this Section are:
   1. ACI 315, Details and Detailing of Concrete Reinforcement.
   2. ASTM A36/A36M, Specification for Carbon Structural Steel.
   3. ASTM A82/A82M, Specification for Steel Wire, Plain, for Concrete Reinforcement.
   4. ASTM A153/A153M, Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   5. ASTM A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   6. ASTM A240/A240M, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   7. ASTM A580/A580M, Specification for Stainless Steel Wire.
   8. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

9. ASTM A663/A663M, Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
10. ASTM A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
11. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
12. ASTM D2240, Test Method for Rubber Property – Durometer Hardness.
13. ASTM D2287, Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
14. UL U904, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR (ANSI/UL 263).
15. UL U905, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR (ANSI/UL 263).
16. UL U906, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR (ANSI/UL 263).
17. UL U907, Nonbearing Wall Rating – 3 or 4 HR (ANSI/UL 263).
18. UL U909, Nonbearing Wall Rating – 3 or 4 HR (ANSI/UL 263).
19. UL U912, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR (ANSI/UL 263).
20. UL U913, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR (ANSI/UL 263).
21. UL U914, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR (ANSI/UL 263).

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide all metal sheet, wire, plate and bar stock masonry anchorages and reinforcing from same manufacturer.
   2. Miscellaneous masonry accessory items other than metal sheet, wire, plate and bar stock shall each be obtained from a single, manufacturer, which may be different from the manufacturer of other products specified in this Section.

B. Regulatory Requirements:
   1. Where fire-resistance classification (four-hour, three-hour, and similar designations) is shown or indicated for unit masonry construction, provide masonry anchorages and reinforcing complying with requirements established by UL tests referenced in this Section (UL U901 through UL U914, as applicable), Laws and Regulations, and requirements of authorities having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit drawings and material schedules showing all dimensions and sizes of masonry anchorages and reinforcing coordinated with unit masonry Work and other Work in which masonry anchorages and reinforcing will be embedded, be supported from, or restrained.
      b. Submit schedule indicating type, location, and spacing of each masonry accessory in unit masonry construction and that type, location, and spacing are in compliance with code requirements.
   2. Product Data:
      a. Manufacturer's product literature and specifications for each masonry accessory required. Include data substantiating that materials comply with the Contract Documents.

3. Samples:
    a. One unit or one modular length of each item specified.

B. Informational Submittals: Submit the following:
1. Manufacturer's Instructions:
    a. Manufacturer’s instructions for handling, storing, and installing for each masonry accessory required.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with:
1. Applicable requirements of standards referenced in this Section.
2. Section 01 6500, Product Delivery Requirements
3. Section 01 6600, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Continuous Horizontal Wire Reinforcing and Ties: Provide the following for all masonry walls unless otherwise shown or indicated:
1. General: Provide the following:
    a. Reinforcement, wire and ties of cold-drawn steel wire complying with ASTM A1064 and hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.
    b. Welded wire units, prefabricated in straight lengths, at least ten feet long, with matching corner “L” and intersection “T” units, all with deformed continuous nine-gage side rods and plain nine-gage truss-type diagonal cross-rods, butt-welded to side rods, not more than 16 inches on centers, with unit width of 1.5 to two inches less than thickness of wall or partition.
    c. Rectangular boxes, pintles and ties fabricated of 3/16-inch diameter wire, unless otherwise specified.
2. Single-wythe and Multi-wythe Masonry Walls (except cavity wall):
    a. Wall reinforcement system with one horizontal rod beneath each unit masonry face shell wall.
    b. Products and Manufacturers: Provide products of one of the following:
        1) Truss Mesh Reinforcement with #120 Truss-Mesh, by Hohmann & Barnard, Inc.
        2) Series 300 Truss Mesh, by Wire-Bond.
        3) Or equal.
3. Multi-wythe Masonry Cavity Walls:
    a. Tab-type wall reinforcing and support system with single pair of side rods in interior wythe, four-inch wide boxes with restraint bar welded across box and adjustable rectangular pintle ties spaced not more than 16 inches on centers. Space side rods for embedment in each face shell wall of back-up wythe and extend box to allow engagement of rectangular pintle box tie for proper embedment in facing wythe.
    b. Products and Manufacturers: Provide one of the following:
        1) #165 Truss, by Hohmann & Barnard, Inc.
        2) Series 700 Truss Adjustable Tab, by Wire-Bond.
        3) Or equal.

4. Provide special, custom-fabricated shapes to accommodate curved cavity, multi-wythe and single-wythe wall construction.

B. Individual Wire Ties for Masonry: Provide the following where shown:
   1. General: Provide the following:
      a. Reinforcing, wire, and ties of Cold-drawn steel wire complying with ASTM A82, and hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153
      b. Crimped with vee-drip for use in cavity wall construction and of length required for proper embedment in outer-most face shell walls of wythes of masonry shown or indicated.
      c. Rectangular box ties and adjustable box ties fabricated of 3/16-inch diameter wire.
   2. Single-piece Ties (where facing and back-up joints align):
      a. For use with hollow masonry units laid with cells vertical and with solid masonry units or hollow units laid with cells horizontal, provide four-inch wide rectangular shaped box-ties.
      b. Products and Manufacturers: Provide one of the following:
         1) Rectangular Box Ties, by Hohmann & Barnard, Inc.
         2) No. 253 Rectangular Wire Ties, by Heckmann Building Products.
         3) Or equal.
   3. Adjustable Two-piece Ties (where facing and back-up joints do not align):
      a. For use with hollow masonry units laid with cells vertical, and with solid masonry units or hollow units laid with cells horizontal, provide four-inch wide adjustable rectangular shaped pintle and eye box-ties.
      b. Products and Manufacturers: Provide one of the following:
         1) Rectangular Adjustable Wall Ties, by Hohmann & Barnard, Inc.
         2) No. 265 Adjustable Box Anchor, by Heckmann Building Products.
         3) Or equal.

C. Anchoring Devices for Masonry: Provide the following, unless otherwise shown or indicated:
   1. General: Provide the following:
      a. Cold-rolled steel sheet complying with ASTM A1008; hot-rolled steel sheet and strip complying with ASTM A1011; plates and bars complying with ASTM A36; and cold-drawn steel wire complying with ASTM A82 all hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153
      b. Rectangular, corrugated, one-inch wide ties, fabricated of 12-gage sheet metal, unless otherwise specified.
      c. Size tie lengths to extend to within one-inch of outside face of outer wythe face shell of opposite face of masonry or to a maximum depth of 12 inches and between 1.5 to two inches less than width of masonry abutting webs and to maximum depth of 12 inches abutting flanges of structural supports. Provide wire crimped with a vee-drip for use in cavity wall construction.
      d. Flexible Anchors: Where masonry abuts structural walls or framework, provide flexible anchors that allow horizontal and vertical movement of masonry, but provides lateral restraint.
   2. Anchorage to Steel Columns and Steel Beam Webs: Provide the following for lateral restraint of unit masonry walls at structural steel framework:
      a. U-shaped, 7.5-inch long channels welded to steel structure, with 5.5 inches of vertical adjustment, fabricated from 11-gage steel with slotted ties.

b. Weld-on, 12-gage, 3/4-inch wide seven-inch long anchor straps providing four inches of vertical adjustment, welded to steel structure.
c. Products and Manufacturers: Provide one of the following:
1) #360 - Gripstay Channels and #364 - Corrugated Gripstay Anchor, by Hohmann & Barnard, Inc.
2) No. 130 Channel Anchor Slots and No. 134 Corrugated Anchor, by Heckmann Building Products.
3) Or equal.
d. Triangular-shaped ties fabricated of 3/16-inch diameter wire with parallel overlapping ends.
e. Rigid, polyvinylchloride or 22-gage steel seismic restraint clips, one for each triangular-shaped tie, 3/16-inches high with four horizontal snap-tight connection grooves, one accommodating nine-gage wire and three accommodating 3/16-inch diameter wire.
f. Continuous, nine-gage wire snap-locked into seismic restraint clips for embedment in outer veneer wythe of masonry.

3. Anchorage to Bottom of Concrete Beams and Slabs and Bottom of Steel Beam Flanges: Provide the following for lateral restraint of unit masonry walls at bottom of beam flanges and concrete slabs:
a. Products and Manufacturers: Provide one of the following:
1) #PTA - 420 - Partition Top Anchors with PTA Tube, by Hohmann & Barnard, Inc.
2) #419 Pin Type with #421 Plastic Tube, by Heckmann Building Products.
3) Or equal.
b. Factory-fabricated partition anchor assembly consisting of 1/4-inch thick plate welded to 3/8-inch diameter, eight-inch long rod at center of plate face. Provide plate with two holes to accept fasteners.
c. Clear acrylic tube with compressible polyethylene filler, one for each rod.

4. Lateral Supporting Masonry Wall Anchors: Provide the following for bracing freestanding walls exceeding allowable unbraced span:
a. Products and Manufacturers: Provide one of the following:
1) #344 Rigid Partition Anchor, by Hohmann & Barnard, Inc.
2) #140 Masonry Anchor, by Heckmann Building Products.
3) Or equal.
b. Plate, 1/4-inch thick by two inches wide fabricated with two-inch long bent legs at 90 degrees to flat face of anchor and of length to extend to center of each wythe of wall, but not less than 2.33 feet long. Cut to length as required.

5. Rebar Positioners: Provide the following:
a. Products and Manufacturers: Provide one of the following:
1) #RB Series and #RB-Twin Series Rebar Positioners, by Hohmann & Barnard, Inc.
2) Rebar Positioners, by Heckmann Building Products.
3) Or equal.
b. Nine-gage reinforcing bar positioners that accommodate both horizontal and vertical reinforcing steel.
c. Fabricate units as required for the Work.

D. Miscellaneous Masonry Accessories: Provide the following where shown:
1. Reinforcing Bars:
a. Deformed carbon steel, ASTM A615, Grade 60 for bars No. 3 to No. 18, except as otherwise shown.

b. Plain carbon steel, ASTM A663, Grade 80 where No. 2 bars are shown or required.
c. Provide galvanized steel reinforcing bars complying with ASTM A153, Class B-1, where shown.

2. Compressible Filler: Provide watertight joint filler where unit masonry construction abuts structural framework members, or as shown. Provide the following:
   a. Products and Manufacturers: Provide one of the following:
      1) Polytite Standard, by Polytite Manufacturing Corp.
      2) Polyseal, by Sandell Manufacturing Company, Inc.
      3) Or equal.
   b. Polyurethane foam strip saturated with polybutylene waterproofing material that, when installed at a compression ratio of two-to-one, is impermeable to water.
   c. Resilient to -40 degrees F with 100 percent movement recovery.
   d. Elongation of 140 percent with a tensile strength of not less than 53 pounds per square inch.
3. Masonry Control Joint Components: Provide the following:
   a. Premolded Control Joint Strips: Provide complete selection of solid extruded rubber and PVC strips with a Shore A durometer hardness of 80 to 90 complying with ASTM D2240 and ASTM D2287, designed to fit standard sash block and maintain lateral stability in masonry wall. Size and configuration shall be as shown.
      1) Products and Manufacturers: Provide one of the following:
         a) #RS12 - Control Joints, by Hohmann & Barnard, Inc.
         b) #2902 and #2903 Rubber Control Joints, by Wire-Bond.Or equal.
   b. Sealants: Refer to Section 07 9200, Joint Sealants.
4. Weep Holes: Provide the following:
   a. Products and Manufacturers: Provide one the following:
      1) #342 - Plastic Weep Holes, by Hohmann & Barnard, Inc.
      2) No. 330 Plastic Weepholes, by Heckmann Building Products
      3) Or equal.
   b. Rectangular 3/8-inch wide by 1.5 inches high, 3.5 inches long clear butyrate tubes.
5. Cavity Fill Mesh: Provide the following:
   a. Products and Manufacturers: Provide one of the following:
      1) #MGS - Mortar/Grout Screen, by Hohmann & Barnard, Inc.
      2) No. 267 Plastic Mesh Wall Ties, by Heckmann Building Products.
      3) Or equal.
   b. Monofilament screen of polypropylene polymers 1/4-inch mesh hardware cloth. Provide below all block courses that are to be filled with mortar.
6. Cavity Drainage Material:
   a. Manufactured of high density polyethelene or nylon strands woven into a 90 percent open mesh
      1) Product and Manufacturer: Provide one of the following:
         a) Mortar Net, by Hohmann and Barnard, Inc.
         b) Mortar Net, by Heckmann Building Products.
         c) Or equal.

2.2 FABRICATION

A. Weld-in-place all channel slots and other specified weld-on anchors at the shop. Field welding is unacceptable.

B. Coordinate location of weld-on anchors and show on structural steel Shop Drawings required under Section 05 1200, Structural Steel Framing.

C. Weld anchor slots and other required accessories in place before shop priming of structural steel.

D. Prime coat weld-on anchors and other accessories and passivate anchor coating in accordance with Section 09 9100, Painting.

E. Shop-fabricate reinforcing bars that are shown or required to be bent or hooked. Comply with ACI 315 for fabricating reinforcing steel for unit masonry Work.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the following:
   1. Section 04 0505, Unit Masonry Construction.

END OF SECTION 04 0519

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SECTION 04 2200

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete unit masonry.
   2. Extent of each type of concrete unit masonry is shown and indicated.
   3. Types of materials and features required include:
      a. Hollow load-bearing units.
      b. Hollow non-load-bearing units.
      c. Solid load-bearing units.
      d. Split-face load-bearing units.
      e. Unit masonry complying with Section 01 4533, Code-Required Special Inspections.
      f. Integral waterproofing admixtures, lightweight aggregates, high recycle content, special and custom shapes required to complete the Work, complete selection of manufacturer's standard and custom colors and other special, and custom features.

B. Related Sections:
   1. Section 04 0505, Unit Masonry Construction.
   2. Section 07 2105, Building Insulation.
   3. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C33, Specification for Concrete Aggregates.
   2. ASTM C90, Specification for Load bearing Concrete Masonry Units.
   3. ASTM C129, Specification for Non-load-bearing Concrete Masonry Units.
   4. ASTM C140, Test Methods for Sampling and Testing Concrete Masonry Units.
   5. ASTM C331, Specification for Lightweight Aggregates for Concrete Masonry Units.
   6. ASTM C426, Test Method for Drying Shrinkage of Concrete Masonry Units.
   7. ASTM C744, Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
   8. ASTM C1093, Practice for Accreditation of Testing Agencies for Unit Masonry.
   9. ASTM C1262, Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units.
   10. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.
   11. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
   12. UL U 904, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
   13. UL U 905, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
   14. UL U 906, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
   15. UL U 907, Nonbearing Wall Rating – 3 or 4 HR.
   16. UL U 909, Nonbearing Wall Rating – 3 or 4 HR.
   17. UL U 912, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.
   18. UL U 913, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating – 2 HR.
   19. UL U 914, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating – 3 HR.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: In accordance with ASTM C1093.

B. Component Supply and Compatibility:
   1. Obtain each type of concrete masonry units from one manufacturer, cured by one process and of uniform texture and color or an established uniform blend texture and color.

C. Regulatory Requirements:
   1. Where fire-resistance classification is shown (four-hour, three-hour, and similar designations) for concrete unit masonry construction, provide materials complying with requirements established by UL tests referenced in this Section (UL U901 through UL U914), Laws and Regulations including applicable building codes, and requirements of authorities having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Complete layout of masonry walls showing modular planning, colors, patterns and all special shapes to be provided. Show details for each condition encountered in the Work. Provide plans and elevation at scale of 1/4-inch equals one foot, and details at scale of 1.5-inch equals one foot.
   2. Product Data:
      a. Manufacturer's specifications, manufacturing procedures, and test data for each material specified. Include instructions for handling, storage, installation, and protection of each type of concrete masonry unit.
      b. Laboratory test reports in accordance with ASTM C140.
   3. Samples:
      a. Submit Sample of each type of concrete masonry unit required. Select each type of concrete masonry unit to show range of color and texture that will be provided in finished Work.
      b. Complete selection of manufacturer's standard and custom colors.
      c. Engineer's review will be for color and texture only. Compliance with other requirements is responsibility of Contractor.

B. Informational Submittals: Submit the following:
   1. Source Quality Control Submittals:
      a. Submit test results as specified in this Section.
   2. Qualifications Statements:
      a. Testing laboratory, if not explicitly included in submittals furnished under other Sections.

1.5 DELIVERY, STORAGE AND HANDLING

A. At time of unloading at Site, concrete masonry units shall comply with ASTM C90, Table 2.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Maintain temperature in area of storage and installation so that masonry products are above 20 degrees F when installed.

PART 2 - PRODUCTS

2.1 GENERAL, CONCRETE UNIT MASONRY

A. General:
1. Unless specifically modified by other requirements of the Contract Documents, provide concrete unit masonry in compliance with classifications, weights, grades, colors, textures, scores, thermal resistance values, and other features specified in this Section.
2. Cure units by autoclave treatment at minimum temperature of 350 degrees F, and minimum pressure of 125 pounds per square inch.

B. Hollow and Solid Load-bearing Concrete Masonry Units: ASTM C90, with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of concrete mix.
1. Minimum compressive strength: 1,900-psi average of three units.

C. Hollow Non-load-bearing Concrete Masonry Units: ASTM C129, with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of concrete mix.

D. Size: Manufacturer's standard units with nominal face dimensions of 16 inches long by eight inches high (15-5/8 inches by 7-5/8 inches actual).

E. Moisture Control:
1. Limit total moisture absorption until time of installation to maximum percentage specified for the weight classification in ASTM C90, Table 2.
2. Total linear dry shrinkage at time of installation shall be less than 0.065 percent.

F. Special Shapes: Provide the following:
1. Lintels, bond beams, reinforcing units, and flush-end reinforcing units, interior and exterior corner shapes, solid jambs, sash block, coves, pre-molded control joint blocks, headers, and other special conditions.
2. Bullnose units for outside vertical corners including doors, windows, louvers and other openings, unless specifically shown on the Drawings indicating that such feature is not required.
3. End blocks at locations where masonry walls abut concrete, or steel columns, to facilitate installation of compressible filler, backer rod, and sealant or fire-rated fire stop sealant systems, if required.

G. Waterproofing Admixture: Manufacture all types of concrete unit masonry used for constructing exterior walls (including interior Wythe of cavity walls) with integral waterproofing admixture as follows:
1. Products and Manufacturers: Provide one of the following:
   a. DRY-BLOCK System, by Grace Construction Products Division, W. R. Grace & Company.
   b. Eucon Blocktite Integral Water-Repellent Masonry Admixture, by Euclid Chemical Company.
   c. Or equal.
2. Material: Cross-linking acrylic polymer.
3. Proportion: In accordance with manufacturer's instructions.

H. Weight: Provide the following:
   1. Provide lightweight concrete masonry units using aggregate complying with ASTM C331 producing dry net weight of not more than 105 pounds per cubic foot.
   2. Provide normal weight split-face concrete masonry units using concrete aggregates complying with ASTM C33 producing dry net weight of not less than 125 pounds per cubic foot.

I. Exposed Faces: Provide manufacturer's standard colors and textures as specified for type of concrete masonry unit.

J. Provide two-core concrete masonry units.

2.2 SPLIT-FACE CONCRETE MASONRY UNITS

A. In addition to requirements applicable to all concrete masonry units, split-face concrete masonry units shall comply with requirements of this Article.

B. Products and Manufacturers: Provide one of the following:
   1. Split-Faced Concrete Unit Masonry, by Oberfield's Inc.
   2. Split-Faced Concrete Unit Masonry, by by Wellnitz.
   3. Or equal.

C. Hollow Load-bearing Split-Face Concrete Masonry Units: Provide the following:
   1. ASTM C90 compliant.
   2. ASTM C426, Dry Shrinkage: 0.025 percent maximum average for five specimens.

D. Color and Texture: Provide the following:
   1. Manufacturer's complete selection of standard colors for selection by Engineer.
   2. Engineer will select maximum of 2 colors and textures for the Work.
   3. Custom Colors: Match Sample approved by Engineer.
   4. Color, surface texture, and aggregate uniform within normal range established by Sample approved by Engineer.

E. Where shown or indicated, provide custom split-face concrete masonry units matching existing in color, texture, and size.

2.3 SOURCE QUALITY CONTROL

A. Tests:
   1. Provide test data verifying total linear drying shrinkage based on tests of concrete masonry units made with same materials, concrete mix proportions, manufacturing process, and curing method, conducted in accordance with ASTM C426. Tests shall have been conducted within 24 months prior to delivery to Site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 04 0505, Unit Masonry Construction.

END OF SECTION 04 2200

SECTION 04 2300

GLASS MASONRY UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install glass masonry unit Work.
   2. Extent of glass masonry units is shown.

B. Related Sections:
   1. Section 04 0511, Masonry Mortaring and Grouting.
   2. Section 07 9200, Joint Sealants.

1.2 REFERENCES

A. Reference Standards: Standards referenced in this Section are:
   1. ASTM C1093, Practice for Accreditation of Testing Agencies for Unit Masonry.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Per ASTM C1093.

B. Component Supply and Compatibility: Obtain each type of glass masonry unit from one manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following
   1. Samples:
      a. One unit of each type of glass masonry unit specified and 6-inch lengths of reinforcing, packing, anchors, and expansion material to be used in the Work.
      b. Engineer's review will be for color and texture only. Compliance with other requirements is responsibility of Contractor.
   2. Shop Drawings:
      a. Complete layout of all glass masonry Work showing modular planning and all shapes used in the Work. Show all details for each condition encountered in the Work. Provide plans and elevations drawn at 1/4-inch scale and details drawn at 1-1/2-inch scale. Show all items required to be built into or that penetrate glass masonry Work.
   3. Product Data:
      a. Copies of manufacturer's product data, specifications, and test data for glass masonry.

B. Informational Submittals:
   1. Certificates: Submit the following:

a. Certification that glass masonry complies with specified requirements.

2. Source Quality Control Submittals:
   a. Laboratory test reports.
3. Supplier Instructions:
   a. Manufacturer's instructions for handling, storing, installing, and protecting glass masonry.
4. Qualifications Data: Submit for approval the following:
   a. Testing Laboratory.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with applicable requirements of referenced standards, Section 01 6500, Product Delivery Requirements, and Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Styles: Provide the following:
   1. Eight-inch by 8-inch by 4-inch modular units with wavy undulations and subtle distortions allowing maximum light transmission.

B. Size: Provide the following:
   1. Manufacturer's standard units, and thicker-faced and fire-rated versions of standard units with nominal face dimensions of eight inches long by eight inches high by four inches thick (7-3/4-inch by 7-3/4-inch by 3-7/8-inches actual).

C. Provide the following physical properties:
   1. U-value: 0.38
   2. Weight (installed with mortar):
      a. Eight-inch by 8-inch Units: Ten pounds per square foot.
   3. Heat Transmission: 0.51 Btu per hour per square foot per degree F.

D. Expansion Strips: White polyethylene, 3/8-inch thick, manufactured by glass masonry unit manufacturer.

E. Asphalt Emulsion: Water-based asphalt emulsion recommended by glass masonry unit manufacturer.

F. Panel Reinforcing: Panel reinforcing shall be hot-dipped galvanized steel double-wire mesh formed of two parallel nine-gage wires spaced at two inches on center with electrically welded cross ties at regular intervals, manufactured by glass masonry unit manufacturer.

G. Panel Anchors: Panel anchors shall be 20-gage perforated steel strips 24 inches long by 1.75 inches wide, galvanized after fabrication, manufactured by glass masonry unit manufacturer.

H. Mortar: Type S, white, portland-cement lime mortar, with an integral acrylic polymer waterproofing, as specified in Section 04 05 11, Masonry Mortaring and Grouting.

I. Sealant and Backer Rod: As specified in Section 07 92 00, Joint Sealants.

J. Products and Manufacturers: Provide products of one of the following:
   1. Premiere Standard Series Decora Glass Block and Thickset Vue and Decora Pattern Block with Decora Hedron Corner Units by Pittsburgh Corning Corp.
   2. Or equal.

2.2 SOURCE QUALITY CONTROL

A. Allowable Tolerances: Provide glass masonry units with all edges and face dimensions made to plus or minus 1/16-inch tolerance.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which glass masonry unit Work will be installed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. Installation:
   1. Coat sill areas to be covered by mortar with a heavy coat of asphalt emulsion. Allow emulsion to dry before placing mortar.
   2. Place expansion strips at jambs and head as recommended by glass masonry unit manufacturer. Expansion strips shall extend to sill.
   3. Provide full mortar bed joint on sill.
   4. Set lower course of glass masonry units. Mortar joints shall be full and not furrowed. Do not use steel tools to tap glass masonry units into position.
   5. Install panel reinforcing in horizontal joints 16 inches on centers maximum. Install horizontal joint reinforcing in joints immediately above and below openings within or discontinuities in glass masonry units even if this results in spacing less than 16 inches. Reinforcing shall run continuously from end to end of glass masonry unit panels and be lapped at least six inches when using more than one length is necessary.
   6. Install horizontal joint reinforcing after placing lower half of mortar in bed joint. Press panel reinforcing into place. Cover panel reinforcing with upper half of mortar bed and trowel smooth. Do not furrow mortar bed.
   7. Place full mortar bed for joints not requiring panel reinforcing. Do not furrow.
   8. Strike joints smooth while mortar is still plastic and before final set. At this time rake out all spaces requiring sealant to a depth equal to width of spaces.
   9. Remove surplus mortar from faces of glass masonry units and wipe dry. Tool joints smooth and concave before mortar takes final set.
   10. After final mortar set, install packing tightly between glass masonry unit panel jamb and head construction. Leave space for sealant.
   11. Apply sealant evenly to full depth of recesses and per sealant manufacturer’s written instructions. Refer to Section 07 9200, Joint Sealants.

3.3 PROTECTION AND CLEANING

A. Perform final cleaning of glass masonry units using techniques recommended by manufacturer of glass masonry units.

END OF SECTION 04 2300

SECTION 05 0533

ANCHOR SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
   2. This Section includes all anchor systems required for the Work, but not specified under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 318, Building Code Requirements for Structural Concrete.
   2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   4. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.
   5. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
   6. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   7. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   8. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   9. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   10. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   12. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   13. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   14. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
   15. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   16. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   17. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   18. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
   19. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
   20. FS A-A-1923A, Concrete Expansion Anchors.
   21. FS A-A-1925A, Shield, Expansion (Nail Anchors).

22. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
23. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
24. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
25. ICC-ES AC60, Acceptance Criteria for Anchors in Unreinforced Masonry Elements.
26. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
27. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
28. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
29. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
   2. Post-installed Anchor Installer:
      a. Mechanical Anchors: Installer shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.
      b. Adhesive Anchors: Installation shall be performed by personnel certified under an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchors Installer Certification Program, or equivalent. Description of equivalent programs shall be submitted for Engineer's approval and acceptance by the building official having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
      b. When required by Engineer, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.
   3. Samples:
      a. Representative Samples of anchor systems proposed for use in the Work. Review will be for type and finish only. Compliance with all other requirements is Contractor's exclusive responsibility.

B. Delegated Design Submittals:
   1. Design Data: Submit the following:
      a. Design Calculations for delegated anchor systems. Structural calculations shall include all specified performance criteria. The magnitude of delegated system/anchorage reactions to supporting structure shall be clearly noted. Design calculations shall be signed, sealed and dated by Contractor's professional engineer.

C. Informational Submittals: Submit the following:
   1. Certificates:
      a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
         1) Reports shall demonstrate compliance with ductile steel element definition of ACI 350, Appendix D, or ACI 318 Chapter 17.
      b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
      c. For each adhesive anchor installer, submit ACI/CRSI Adhesive Anchor Installer Certification.
   2. Manufacturer's Instructions:
      a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Keep materials dry during delivery and storage.
   2. Store adhesive materials within manufacturer's recommended storage temperature range.
   3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
   2. Stainless Steel Nuts:
      a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
      b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
   3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria
   1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:

a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.

b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.

1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.

2) Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.

3) Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.

4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.

5) Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by Engineer, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.

6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by Engineer, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.

2. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to Contractor, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents. Anchor system shall be designed by a professional engineer, retained by Contractor, Subcontractor, or Supplier, registered in the same state as the Site, with proper consideration of concrete strength, spacing and edge distance.

a. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:

1) Equipment Anchors: Use static and dynamic design loads recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.

2) Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.

3) Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.

C. Application:
1. Anchor Bolts:
   a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by Engineer.
   b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
2. Concrete Adhesive Anchors:
   a. Use where adhesive anchors are shown or indicated for installation in concrete.
   b. Suitable for use where subject to vibration.
   c. Suitable for use in exterior locations or locations subject to freezing.
   d. Suitable for use in submerged, intermittently submerged, or buried locations.
   e. Do not use in overhead applications, unless otherwise shown or approved by Engineer.
   f. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.
3. Concrete Masonry Adhesive Anchors:
   a. Use where adhesive anchors are shown or indicated for installation in grout-filled or hollow masonry units.
   b. Suitable for use where subject to vibration.
   c. Suitable for use in exterior locations or locations subject to freezing.
   d. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.
4. Concrete Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in concrete.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
   d. Do not use in submerged, intermittently submerged, or buried locations.
   e. Suitable for use in overhead applications.
5. Grout-filled Concrete Masonry Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
6. Hollow Concrete Masonry Sleeve Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use in exterior locations or locations subject to freezing.
7. Drop-in Expansion Anchors:
   a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use at submerged, intermittently submerged, or buried locations.

e. Do not use in exterior locations or locations subject to freezing.
f. Suitable for use in overhead applications.

8. Concrete Inserts:
   a. Use only where shown or indicated in the Contract Documents.
   b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
9. Drive-In Expansion Anchors:
   a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use in overhead applications.
10. For Use in Precast Concrete Planks:
    a. To support piping or conduit two-inch diameter and smaller, use low-profile drop-in anchors, hollow concrete masonry adhesive anchors, or through-bolts.
    b. For piping greater than two-inch diameter, or to support safety-related systems, use through-bolts. Each through-bolt shall consist of threaded rod, nuts, washers, and bearing plate.

2.2 MATERIALS

A. Anchor Bolts:
   1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade 55, with heavy hex nuts complying with ASTM A563 Grade A, unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.
   2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by Engineer. Hooked bolts are unacceptable.
      a. Stainless steel straight threaded rod shall comply with ductility requirements of ACI 350 Appendix D or ACI 318 Chapter 17.
   3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.
   4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:
   1. General:
      a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-RE 500-V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
      b. HIT-HY 200-A and HIT-HY 200-R Adhesive Anchoring System, by Hilti Fastening Systems, Inc
      c. SET-XP Adhesive anchoring system, by Simpson Strong-Tie Company, Inc.
      d. Or equal.

3. Adhesive:
    a. Adhesive system shall use two-component adhesive mix.
    b. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308, which incorporates the requirements of ACI 355.4-11
    c. Adhesives shall have minimum bond strength and minimum design bond strength in accordance with Table 05 0533-A:

TABLE 05 0533-A:
ADHESIVE BOND STRENGTH [1,2]

Bond Strength (psi)					
Rod Diameter	**Uncracked Concrete**	**Cracked Concrete**	**Dowel Size**	**Uncracked Concrete**	**Cracked Concrete**
1/2-inch	1670	880	#4	1500	1080
5/8-inch	1670	750	#5	1460	1090
3/4-inch	1670	665	#6	1415	1015
7/8inch	1525	610	#7	1370	835
1-inch	1360	595	#8	1330	760
-	-	-	#9	1560	850
1.25-inch	1070	595	#10	1240	475

Table Notes:
1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 130 degrees F and maximum long term concrete temperature of 110 degrees F.

4. Anchor:
    a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
    b. Stainless steel threaded rod shall comply with ductility requirements of ACI 350 Appendix D or ACI 318 Chapter 17.

C. Concrete Masonry Adhesive Anchors:
1. General:
    a. Grout-filled concrete masonry adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
    b. Hollow concrete masonry adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
    a. HIT-HY 270 Hybrid Adhesive Anchor System, by Hilti Fastening Systems, Inc.
    b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
    c. Or equal.
3. Adhesive:
    a. Adhesive system shall use two-component adhesive mix.

b. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES AC58 and ICC-ES AC60.

4. Anchor:
   a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
5. Mesh Screen Tube (for hollow masonry applications):
   a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.

D. Concrete Wedge Expansion Anchors:
1. General:
   a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
2. Products and Manufacturers: Provide one of the following:
   a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
   b. Strong Bolt 2 Wedge Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 Chapter 17 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.
6. Anchor shall comply with ductility requirements of ACI 350 Appendix D or ACI 318 Chapter 17.
7. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

E. Grout-filled Masonry Wedge Expansion Anchors:
1. General:
   a. Grout-filled masonry wedge expansion anchors shall each consist of stud, wedge, nut, and washer.
2. Product and Manufacturers: Provide one of the following:
   a. Kwik-Bolt 3 Expansion Anchors, by Hilti Fastening Systems, Inc.
   b. Wedge-All Wedge Anchors, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Anchors shall be non-bottom bearing type with single-piece steel expansion clip providing 360-degree contact with base material and shall not require oversized holes for installation.
4. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Grout-filled masonry wedge expansion anchors shall have a current ICC Evaluation Service report for use in fully-grouted concrete masonry construction when tested and assessed in accordance with ICC-ES AC01.

F. Hollow Concrete Masonry Sleeve Expansion Anchors:
1. General:

a. Sleeve expansion anchors shall each consist of an externally threaded stud with full length expanding sleeve.

2. Products and Manufacturers: Provide one of the following:
   a. HLC Sleeve Anchors, by Hilti Fastening Systems, Inc.
   b. Dynabolt Sleeve Anchors, by ITW Red Head.
   c. Or equal.
3. Anchors shall comply with physical requirements of FS A-A-1922A. Anchors shall be non-bottom bearing type with single-piece steel expansion sleeve providing 360-degree contact with base material and shall not require oversized holes for installation.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, Type 304 stainless steel, in accordance with ASTM A276 or ASTM A493.

G. Drop-in Expansion Anchors:
1. General:
   a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
2. Products and Manufacturers: Provide one of the following:
   a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
   b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or equal.
3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

H. Concrete Inserts:
1. Manufacturers: Provide products of one of the following:
   a. Unistrut Corporation.
   b. Cooper B-Line, Inc.
   c. Anvil International, Inc.
   d. Or equal.
2. Spot Concrete Inserts:
   a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
3. Continuous Concrete Inserts:
   a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.
4. Provide inserts with plain finish.

I. Drive-In Expansion Anchors:
1. General:
   a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
2. Products and Manufacturers: Provide one of the following:
   a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.

b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
c. Or equal.

3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.

J. Unless approved by Engineer, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.

K. Anti-Seizing Compound:
1. Products and Manufacturers: Provide one of the following:
a. Pure Nickel Never-Seez, by Bostik.
b. Or equal.
2. Provide pure nickel anti-seizing compound.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and advise Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Anchor Bolts:
1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
3. Protect threads and shank from damage during installation and subsequent construction operations.
4. Unless otherwise shown or approved by Engineer anchor bolts shall comply with Table 05 05 33-B:

TABLE 05 0533-B:
SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS [1]

Bolt Diameter (inch)	F1554 Grade 36 F593 Type 316, Condition A				F1554 Grade 55			
	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3,4] (lb)	Tension[3] (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)
1/2	6	9	947	1,815	8.5	12.75	1,245	2,393
5/8	7.5	11.25	1,508	2,895	10.5	15.75	1,980	3,810
3/4	9	13.5	2,231	4,290	13	19.5	2,933	5,640
7/8	10.5	15.75	3,080	5,918	15	22.5	4,050	7,793
1	12	18	4,040	7,770	17	25.5	5,318	10,088
1 1/8	13.5	20.25	5,090	9,789	19	28.5	8,930	12,435
1.1/4	15	22.5	6,463	12,429	21	31.5	8,505	15,030

Table Notes:

1. Table is based on ACI 318 Chapter 17 and ACI 350, Appendix D, f'c = 4000 psi. Table 05 05 33-B is not applicable to anchor bolts embedded in grouted masonry.
2. Critical edge distance and spacing are indicated in the table. Capacity of anchor bolts for other combination of edge distances and spacing shall be evaluated in accordance with ACI 318 Chapter 17 and ACI 350, Appendix D.
3. Values for shear and tension listed are not considered to act concurrently. Interaction of tension and shear will be evaluated by Engineer in accordance with ACI 318 Chapter 17 and ACI 350, Appendix D.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:
   1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain Engineer's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:
   1. Installation conditions shall comply with all requirements of the approved product Evaluation Service Report (ESR), including "Conditions of Use." Comply with manufacturer's written installation instructions and the following.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
   3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
   4. Before injecting adhesive, obtain Engineer's concurrence that hole is dry and free of oil and other contaminants.
   5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
   6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
   7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
   8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by Engineer.
   9. Limitations:
      a. At time of anchor installation, concrete shall have compressive strength (f'c) of not less than 2,500 psi.
      b. At time of anchor installation, concrete shall have age of not less than 21 days.
      c. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
      d. Oversized Holes: Advise Engineer immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but

not limited to redesign of anchors due to decreased anchor capacities, shall be paid by Contractor.

e. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

D. Expansion Anchors:
   1. Comply with expansion anchor manufacturer's written installation instructions and the following:
   2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.
   3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
   4. Before installing anchor, obtain Engineer's concurrence that hole is dry and free of oil and other contaminants.
   5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Inserts:
   1. Comply with concrete insert manufacturer's installation instructions.
   2. Inserts shall be flush with slab bottom surface.
   3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
   4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.

F. Anti-Seizing Compound:
   1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1.B of this Section.
   2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. Owner Will employ testing agency to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
      a. Testing shall comply with ASTM E488.
      b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, Contractor shall pay cost of testing all anchors of the same type installed in the Work. Contractor shall be responsible for retesting costs.

c. Engineer will direct which adhesive anchors are to be tested and indicate test load to be used
d. Apply test loads with hydraulic ram.
e. Displacement of post-installed anchors shall not exceed D/10, where D is nominal diameter of anchor being tested.

B. Manufacturer's Services:
1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train Contractor's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

END OF SECTION 05 0533

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SECTION 05 1200

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install structural steel framing, including surface preparation and shop priming.
2. Structural steel framing is the Work defined in AISC 303, Section 2, and as shown or indicated in the Contract Documents. The Work also includes:
   a. Providing openings in and attachments to structural steel framing to accommodate the Work under this and other Sections, and providing for structural steel framing items such as anchorage devices, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before structural steel framing Work.

C. Related Sections:
1. Section 03 6000, Grouting.
2. Section 05 0533, Anchor Systems.
3. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 325, Steel Construction Manual.
3. AISC 360, Specification for Structural Steel Buildings.
4. ASME B46.1, Surface Texture (Surface Roughness, Waviness and Lay).
5. ASTM A6/A6M, Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
6. ASTM A36/A36M, Specification for Carbon Structural Steel.
7. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
8. ASTM A108, Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
9. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
10. ASTM A325, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.
11. ASTM A490, Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
12. ASTM A500/A500M, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A563, Specification for Carbon and Alloy Steel Nuts.

14. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
15. ASTM A992/A992M, Specification for Structural Steel Shapes.
16. ASTM A1085/A1085M, Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
17. ASTM E329, for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
18. ASTM F436, Specification for Hardened Steel Washers.
19. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
20. ASTM F959, Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
21. ASTM F1852, Specification for "Twist off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
22. AWS D1.1/D1.1M, Structural Welding Code-Steel.
23. RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Steel Fabricator:
      a. Structural steel fabricating plant shall possess current certificate from AISC stating that the fabrication facility complies with requirements for "Certified Building Fabricator" (BU) of AISC's quality certification program. Fabricating plant shall maintain this certification throughout time of fabrication for this Project.
   2. Welders and Welding Processes:
      a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, Section 5, Qualification.
      b. Each welder employed on or to be employed for the Work shall possess current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing proposed sequence of erection. Shop Drawings shall not be reproductions of Contract Drawings.
      b. Include complete information for fabrication of the structure's components, including but not limited to location, type, and size of bolts, details of blocks, copes and cuts, connections, camber, holes, member sizes and lengths, and other pertinent data. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld.
      c. Setting drawings, templates, and directions for installing anchorage devices.
   2. Product Data:
      a. Manufacturer's specifications and installation instructions for products listed below.
         1) High-strength bolts of each type, including nuts and washers.
         2) Welding electrodes and rods.
         3) Load indicator bolts and washers.

B. Informational Submittals: Submit the following:

1. Certificates.
    a. Fabricator's AISC quality certification.
    b. Welders' certifications.
    c. Certified reports of laboratory tests on previously-manufactured, identical materials, and other data as necessary, to demonstrate compliance with the Contract Documents for the materials listed below:
        1) Structural steel of each type, including certified mill reports indicating chemical and physical properties.
        2) High-strength bolts of each type, including nuts and washers.
2. Supplier Instructions:
    a. Installation data, handling, and storage instructions.
3. Source Quality Control Submittals:
    a. When performed or when required by Engineer, submit results of source quality control testing and inspections performed at the mill or shop.
4. Field Quality Control Submittals:
    a. Written field survey reports for all bearing surfaces surveyed, verifying tolerance requirements, areas out of tolerance, and corrective measures required.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage:
1. Protect steel members and packaged materials from corrosion and deterioration.
2. Do not store materials in or on the building or structure in manner that may cause distortion or damage to structural steel members, building, or supporting structures.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Types:
1. W-Shapes and WT-Shapes: ASTM A992/A992M.
2. S-shapes and Channels: ASTM A572/A572M, Grade 50.
3. Hollow Structural Sections: ASTM A1085 or ASTM A500/A500M, Grade C.
4. Angles, Plates, and Bars: ASTM A36/A36M.
5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Anchorages, Fasteners, and Connectors:
1. Anchorage Devices: Refer to Section 05 0533, Anchor Systems.
2. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
    a. Unless otherwise indicated, fasteners shall be quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325, Type I, nuts complying with ASTM A563C, A563DH or A194/A194M 2H, and hardened washers complying with ASTM F436. Bolts, nuts and washers shall be hot-dip galvanized where shown or indicated.
    b. Tension control bolts, when used, shall comply with ASTM F1852.
    c. Compressible washer-type direct-tension indicators, when used, shall comply with ASTM F959, Type 325.
3. Threaded Rod: Provide threaded rods with heavy hexagon nuts, and hardened washers, as follows:

a. Interior and Dry Locations: Provide threaded carbon steel rods complying with ASTM A36, with heavy hex nuts complying with ASTM A563A, unless otherwise shown or indicated on the Drawings.
b. Exterior, Buried, or Submerged Locations, or When Exposed to Wastewater: Provide stainless steel threaded rods complete with washers complying with ASTM F593, AISI Type 316, Condition A, with ASTM A194/A194M, Grade 8S (nitronic 60) stainless steel nuts. Other AISI types may be used when approved by Engineer.

C. Electrodes for Welding: E70XX complying with AWS D1.1/D1.1M.

2.2 FABRICATION

A. Shop Fabrication and Assembly:
1. General:
a. Fabricate and assemble structural assemblies in the shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC 325, the Contract Documents, and as shown on approved Shop Drawings. Provide camber in structural members as shown or indicated.
b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize handling of materials for storage and minimize handling at the Site.
c. Where finishing is required, complete the assembly, including welding of units, before commencing finishing operations. Provide finish surfaces of members exposed-to-view in the completed Work that are free of markings, burrs, and other defects.
2. Connection design:
a. The design of connections for any part of the structure not indicated on the Contract Drawings shall be completed by the Contractor, under the supervision of a professional engineer registered in the same state as the Site. Professional engineer shall sign/seal all calculations and shop drawings related to connection design.

B. Connections:
1. Shop Connections:
a. Unless otherwise shown or indicated, shop connections may be welded or high-strength bolted connections. Welds shall be 3/16-inch minimum.
b. Where reaction values of beam are not shown or indicated, connections shall be detailed to support 70% of the total uniform load capacity tabulated in tables contained in part 10 of the AISC Manual for allowable loads on beams for the associated shape, span, and steel specified for the beam. Reaction used for design shall not be less than 6 kips.
c. Shop-welded connections shall be detailed to eliminate or minimize eccentricity in the connection.
d. End-connection angles fastened to webs of beams and girders, and the thickness of angles, size, and extent of fasteners or shop welds, shall comply with tables of "Framed Beam Connections" in AISC 325. Connections shall be two-sided, unless otherwise shown or indicated.
2. Field Connections:
a. Field connections, unless otherwise shown or indicated, shall be made with high-strength bolts, and shall be bearing-type connections.
b. Use field welding only where shown or indicated or where approved by Engineer.
3. High-Strength Bolted Construction:

a. Provide high-strength threaded fasteners in accordance with RCSC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.
b. High-strength bolt design shear values shall be as specified in AISC 325 for bolts with threads in the shear plane for bearing type connections, or as specified in this Section for slip-critical connections.
c. Bolted connections shown or indicated as "SC" shall comply with slip-critical connection requirements in RCSC Specifications for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
1) Faying surfaces shall have a Class A surface condition.
2) Slip-critical bolts shall be fully pre-tensioned to 70 percent of minimum specified tensile strength of the bolt using one of the following methods:
a) Turn of nut with matchmarking.
b) Twist-off tension control bolt (ASTM F1852).
c) Direct tension indicator washer (ASTM F959).
d. Minimum bolt diameter shall be 3/4-inch, unless otherwise shown or indicated.

4. Welded Construction: Comply with AWS D1.1/D1.1M for procedures, appearance, and quality of welds, and methods used in correcting defective welding Work.
5. Where rigid connections are required by stresses shown or indicated, provide web shear reinforcement and stiffeners in accordance with AISC 360.

C. Bracing:
1. Bracing for which stress is not shown or indicated shall have minimum two-bolt connection, or shop-welded connection of equivalent strength.
2. Vertical bracing and knee braces connecting to columns shall be on the centerline of columns, unless otherwise shown or indicated.
3. Knee braces shall be at 45-degree angle, unless otherwise shown or indicated.
4. Gussets shall be not less than 3/8-inch thick, unless otherwise shown or indicated.

D. Columns: Column shafts shall have finished bearing surface roughness not greater than 500 micro-inch in accordance with ASME B46.1, and ends shall be square within tolerances for milled ends in accordance with ASTM A6/A6M at the base and at splice lines.

E. Structural Tubing: Properly seal structural tubing to protect internal surfaces.

F. Holes and Appurtenances for Other Work:
1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on the approved Shop Drawings. If large block-outs are required and approved, reinforce the webs to develop specified shears. Provide threaded nuts welded to framing and other specialty items as shown or indicated to receive other work.
2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 FINISHING

A. All exterior steel shall be hot-dip galvanized and painted.

B. Surface Preparation and Shop Priming: Structural steel shall be primed in the shop. For surface preparation and shop priming requirements refer to Section 09 9100, Painting.

2.4 SOURCE QUALITY CONTROL

A. Inspection and Testing at the Mill or Shop:
   1. Perform fabricator's standard procedures for source quality control, including inspections and testing.
   2. Materials and fabrication procedures shall be subject to inspection and tests in mill and shop, conducted by a qualified inspection laboratory. Such inspections and tests do not relieve Contractor of responsibility for providing the Work in accordance with the Contract Documents.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which the Work will be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 ERECTION

A. General: Comply with AISC 303, AISC 360, and the Contract Documents.

B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy-lines to achieve proper alignment of structures as erection proceeds.

C. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete the Work. Provide sufficient planking to comply with Laws and Regulations, and provide tightly-planked substantial floor within two stories or 30 feet, whichever is less, below each tier of steel beams on which work is performed.

D. Anchorage Devices:
   1. Provide anchorage devices, including anchor bolts, and other connectors required for securing structural steel to foundations and other in-place construction.
   2. Provide templates and other devices necessary for presetting anchorage devices to accurate locations.
   3. Refer to Section 05 0533, Anchor Systems, for anchorage requirements.

E. Setting Bases and Bearing Plates:
   1. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
   2. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.
   3. Tighten anchorage devices after supported members are positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
   4. Place grout between bearing surfaces and bases or plates in accordance with Section 03 6000, Grouting. Finish exposed surfaces, protect installed materials, and allow to cure in accordance with grout manufacturer's instructions, and as otherwise required.
   5. Do not use leveling plates or wood wedges.

F. Field Assembly:
   1. Set structural frames accurately to the lines and elevations shown and indicated. Align and adjust the various members forming part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   2. Level and plumb individual members of structure within tolerances as specified in AISC 325. For members requiring accurate alignment, provide clip angles, lintels, and other members, with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
   3. Splice members only where shown or indicated.

G. Erection Bolts: On exposed-to-view, welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

H. Connections:
   1. Comply with AISC 325 for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
   2. Do not enlarge inadequate holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

I. Gas Cutting: Do not use gas-cutting torches for correcting fabrication defects in structural framing. Cutting will be allowed only on secondary members that are not under stress, as approved by Engineer. Finish gas-cut sections equal to a sheared appearance, when allowed.

J. Touch-up Painting:
   1. Unless otherwise specified, comply with touch-up painting requirements in Section 09 9100, Painting.
   2. Immediately after erection, clean field welds, bolted connections, and damaged or abraded areas of shop-applied paint. Apply paint to exposed areas with the same paint or coating material applied in the shop. Apply by brush or spray to provide not less than the dry film thickness specified in Section 09 9100, Painting.

3.3 FIELD QUALITY CONTROL

A. Site Tests and Inspections: Materials and erection procedures shall be subject to inspection and tests at the Site conducted by qualified inspection laboratory. Such inspections and tests do not relieve Contractor of responsibility for providing the Work in accordance with the Contract Documents.
   1. Owner will engage independent testing and inspection laboratory to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
      a. Testing laboratory shall conduct and interpret tests, prepare and state in each report of results whether test specimens comply with the Contract Documents and specifically indicate all deviations.
      b. High-strength Bolted Connections: Each high-strength bolted connection shall be visually inspected. Inspection shall identify whether the Work complies with Sections 2, 3, and 8 of RCSC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
         1) For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning.

2) For connections that are not slip critical and not subject to direct tension, bolt does not need to be inspected for bolt tension, but shall be visually inspected to verify that plies of connected elements are in snug contact.
3) Where bolts or connections are defective, correct defective workmanship, remove and replace, or correct as required defective bolts and connections. Contractor shall pay for correcting defective Work and tests required to confirm integrity of corrected Work.

c. Welds: Each weld shall be visually inspected.
1) Where visually defective welds are evident, further test welds using non-destructive methods. If welds are determined to be acceptable, Owner will pay for non-destructive testing. When welds are defective, Contractor shall pay for non-destructive testing.
2) Correct, or remove and replace, defective Work as directed by Engineer.
3) Contractor shall pay for corrections and subsequent tests required to determine weld compliance with the Contract Documents.

END OF SECTION 05 1200

SECTION 05 1400

STRUCTURAL ALUMINUM FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install structural aluminum framing.
   2. The Work also includes:
      a. Providing openings in and attachments to structural aluminum framing to accommodate the Work under this and other Sections, and providing for structural aluminum framing items such as anchorage devices, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before structural aluminum framing Work.

C. Related Sections:
   1. Section 03 6000, Grouting.
   2. Section 05 0533, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AA ADM-1, Aluminum Design Manual – Specifications for Aluminum Structures.
   2. AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts, approved by RCSC.
   3. ASTM A325, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 KSI Minimum Tensile Strength.
   4. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   5. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   6. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
   7. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
   8. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
   9. ASTM B429/B429M, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
   10. ASTM F436, Standard Specification for Hardened Steel Washers.
   11. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   12. ASTM F594, Specification for Stainless Steel Nuts.
   13. AWS D1.2/D1.2M, Structural Welding Code - Aluminum.
   14. NAAMM AMP 500, Metal Finishes Manual for Architectural and Metal Products.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Welders and Welding Processes:
      a. Qualify welding processes and welding operators in accordance with AWS D1.2/D1.2M.
      b. When requested by Engineer, provide certification that all welders employed on or to be employed on the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing proposed sequence of erection. Shop Drawings shall not be reproductions of Contract Drawings.
      b. Include complete information for fabrication of the structure's components, including location, type, and size of bolts, details of blocks, copes and cuts, connections, camber, holes, member sizes and lengths, and other pertinent data. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld.
      c. Provide setting drawings, templates, and directions for installing anchorage devices.
   2. Product Data:
      a. Copies of manufacturer's specifications and installation instructions for products listed below.
         1) Welding electrodes and rods.

B. Informational Submittals: Submit the following:
   1. Certificates.
      a. Welders' certifications, when requested by Engineer.
   2. Test Reports.
      a. Laboratory test reports and other data required to show compliance with the Contract Documents for the following:
         1) Mill test report documenting chemical and physical properties of each type of aluminum framing material.
         2) Mill test report documenting chemical and physical properties of stainless steel connection bolts, nuts, and washers.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the Site at such intervals to ensure uninterrupted progress of the Work.

B. Storage:
   1. Do not store materials in a manner that could cause distortion or damage to the members. Repair or replace damaged materials as directed by Engineer.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Aluminum Types:
   1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B221, Alloy 6061-T6.
   2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
   3. Aluminum Bars and Rods: ASTM B211, Alloy 6061-T6.
   4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

B. Anchorages, Fasteners, and Connectors:
   1. Anchorage Devices: Refer to Section 05 0533 Anchor Systems.
   2. Threaded Fasteners: Stainless steel bolts, ASTM F593, AISI Type 303, and stainless steel nuts and washers, ASTM F594, AISI Type 303.
   3. Bolts used in slip-critical connections shall comply with ASTM A325; nuts shall comply with ASTM A563 Grade DH; and washers shall comply with ASTM F436. Bolts, nuts, and washers shall be zinc-coated by the hot-dip process in accordance with ASTM A325.

C. Electrodes for Welding: ER 5356 complying with AWS D1.2/D1.2M.

D. Finish: Provide mill finish as specified in NAAMM AMP 500.

2.2 FABRICATION

A. Shop Fabrication and Assembly:
   1. General:
      a. Fabricate and assemble structural assemblies in the shop to greatest extent possible. Fabricate items of structural aluminum in accordance with AA ADM-1, the Contract Documents, and as shown on approved Shop Drawings. Provide camber in structural members as shown.
      b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize handling of materials for storage and minimize handling at the Site.
      c. Where finishing is required, complete the assembly, including welding of units, before commencing finishing operations. Provide finish surfaces of members exposed-to-view in the completed Work that are free of markings, burrs, and other defects.

   2. Connection Design:
      a. The design of connections for any part of the structure not indicated on the Contract Drawings shall be completed by the Contractor, under the supervision of a professional engineer registered in the same state as the Site. Professional engineer shall sign/seal all calculations and shop drawings related to connection design.

B. Connections:
   1. Shop Connections:
      a. Unless otherwise shown or indicated, shop connections may be welded or stainless steel bolted. Unless shown otherwise, welds shall be 1/4-inch minimum.
      b. Where reaction values of a beam are not shown or indicated, connections shall be detailed to support the total uniform load capacity tabulated in AA ADM-1 tables for

allowable loads on beams for the given shape, span, and aluminum specified for beam in question.

c. Shop-welded connections shall be detailed to eliminate or minimize eccentricity in the connection.

d. End connection angles fastened to webs of beams and thickness of angles, size and extent of fasteners or shop welds, shall comply with design standards in AA ADM-

1) Details shown on the Drawings are typical; similar details apply to similar conditions, unless otherwise shown or specified.

2. Fabrication Considerations Regarding Field Connections:

a. Unless otherwise specified below or indicated, make field connections using stainless steel bolts.

b. Field welding is not allowed.

3. Bolted Construction:

a. Stainless steel design shear values shall be based on bolts with bearing type connections with threads in the shear plane.

b. Bolted connections shown or indicated as "SC" shall comply with slip-critical connection requirements in AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

1) Faying surfaces shall have a Class B surface condition.

2) Slip-critical bolts shall be fully pre-tensioned as indicated in AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

c. Minimum bolt diameter shall be 3/4-inch, unless otherwise shown or indicated.

4. Welded Construction: Comply with AWS D1.2/D1.2M for procedures, appearance, and quality of welds, and methods used in correcting defective welding Work.

C. Bracing:

1. Bracing for which stress is not shown or indicated shall have minimum two-bolt connection, or shop-welded connection of equivalent strength.

2. Vertical bracing and knee braces connecting to columns shall be on the centerline of columns, unless otherwise shown or indicated.

3. Knee braces shall be at 45-degree angle, unless otherwise shown or indicated.

4. Connection plates shall be minimum 3/8-inch thick, unless otherwise shown.

D. Columns: Fabrication tolerances shall be as required by AA ADM-1 and AWS D1.2/D1.2M for welded members.

E. Holes and Appurtenances for Other Work:

1. Provide holes required for securing other work to structural aluminum framing, and for passage of other work through framing members, as shown on the Shop Drawings and the Contract Documents. If large block-outs are required and approved, reinforce the webs to develop specified shear strength. Provide threaded nuts welded to framing, and other specialty items as shown to receive other work.

2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not frame cut holes or enlarge holes by burning. Drill holes in bearing plates.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which structural aluminum Work will be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 ERECTION

A. Comply with AA ADM-1 and the Contract Documents.

B. Anchorage Devices:
   1. Provide anchorage devices, including anchor bolts, and other connectors required for securing structural aluminum to foundations and other in-place Work.
   2. Provide templates and other devices necessary for pre-setting anchorage devices to accurate locations.
   3. Refer to Section 05 0533, Anchor Systems, for anchorage requirements.

C. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
   1. Set loose and attached base plates and bearing plates for structural members on stainless steel wedges or other adjusting devices.
   2. Tighten anchorage devices after positioning and plumbing supported members. Do not remove wedges or shims, but if protruding, cut off flush with edge of the base or bearing plate prior to packing with grout.
   3. Place non-shrink grout between bearing surfaces and bases or plates in accordance with Section 03 6000, Grouting. Finish exposed surfaces, protect installed materials, and cure in compliance with grout manufacturer's instructions.
   4. Leveling plates and wood wedges are not allowed.

D. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure within tolerances specified in AA ADM- For members requiring accurate alignment, provide clip angles, lintels and other members shall be with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
   2. Splice members only where shown or indicated.

E. Erection Bolts: On exposed, welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

F. Gas Cutting: Do not use gas-cutting torches at the Site for correcting structural framing fabrication errors. Field-cutting will be allowed only on secondary members that are not under stress, as approved by Engineer. Finish gas-cut sections equal to sheared appearance when allowed.

G. Protection of Aluminum from Dissimilar Materials:

1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 9100, Painting.

3.3 FIELD QUALITY CONTROL

A. Owner will engage an independent testing and inspection agency to inspect stainless steel bolted connections and welded connections as follows:
   1. Visually inspect all welds. Test wells that appear to be visually deficient using non-destructive methods by qualified testing laboratory. Contractor shall correct improper workmanship by removing and replacing, or repairing, as instructed by Engineer, welds that are defective. Pay for all corrections and subsequent retesting to confirm integrity of welds.
   2. Visually inspect all bolted connections.
      a. Visually inspect connections to verify that plies of connected elements are in snug contact.
      b. For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning in accordance with Paragraph 2.2.B.3.b of this Section.
      c. Where bolts or connections are defective, correct improper workmanship and materials by removing defective bolts and connections and replacing or repairing as directed by Engineer. Pay for corrections and subsequent tests required to confirm integrity of connection.
   3. Independent testing and inspection agency shall prepare a report on each structure. Report shall summarize observations made by inspector and be submitted to Engineer.

B. Correct defecctive structural aluminum Work. Perform additional tests, at Contractor's expense, necessary to confirm non-compliance of the original Work and to demonstrate compliance of corrected Work.

+ + END OF SECTION + +

SECTION 05 4000

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all professional services, labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install cold-formed metal framing.
2. The extent of cold-formed metal framing work is generally shown on the Contract Drawings.
3. This Section includes the following:
   a. Load-bearing wall framing
   b. Non-load-bearing wall framing

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before cold-formed metal framing Work.

C. Related Sections:
1. Section 05 0533, Anchor Systems
2. Section 09 2216, Non-Structural Metal Framing.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. AISI D100, Cold-Formed Steel Design Manual.
2. AISI D110, Cold-Formed Steel Framing Design Guide.
3. AISI D112, Brick Veneer Cold-Formed Steel Framing Design Guide.
4. AISI S100, North American Specification for the Design of Cold-Formed Steel Structural Members.
5. AISI S240, North American Standard for Cold-Formed Steel Structural Framing.
6. AISI S400, North American Standard for Seismic Design of Cold-Formed Steel Structural Framing.
7. ASCE 7, Minimum Design Loads for Buildings and Other Structures
8. ASTM A36/A36M, Standard Specification for Carbon Structural Steel.
9. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
10. ASTM A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
11. ASTM C1513, Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
12. ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
13. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

14. ASTM E1190, Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members.
15. AWS D1.3, Structural Welding Code-Sheet Steel.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer shall have a minimum of five years' experience producing substantially similar products and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
2. Professional Engineer:
   a. Engage a registered professional engineer legally qualified to practice in the same jurisdiction as the Site and experienced in providing engineering services of the kind indicated.
   b. Submit qualifications data.
   c. Responsibilities include:
      1) Carefully reviewing cold-formed metal framing performance and design criteria stated in the Contract Documents.
      2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
      3) Preparing or supervising preparation of design calculations and related drawings, Shop Drawings, and comprehensive engineering analyses verifying compliance of cold-formed metal framing with requirements of the Contract Documents.
      4) Signing and sealing all calculations, design drawings, and Shop Drawings.
      5) Certifying that:
         a) it has performed the design of cold-formed metal framing in accordance with performance and design criteria stated in the Contract Documents, and
         b) said design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice
3. Installer:
   a. Engage a single installer skilled, trained and with documented experience in the erection of cold-formed metal framing systems with specific skill and successful experience in the erection of the types of components required.
4. Testing Laboratory:
   a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
   b. Testing laboratory shall comply with the requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor, and demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E329.
5. Welders and Welding Processes:
   a. Qualify procedures and personnel according to AWS D1.3.
   b. Submit certification that each welder employed on or to be employed for the Work possesses current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work

B. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of the component manufacturer from a single cold-formed metal framing manufacturer.
2. The cold-formed metal framing manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the cold-formed metal framing manufacturer.

C. Product Tests: Mill certificates or data from a qualified independent testing agency or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

D. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

E. Regulatory Requirements: Comply with applicable requirements of Laws and Regulations, including governing building codes. Fabricate and label structural cold-formed metal framing to comply with material verification and special inspection requirements of the governing Building Code and Authorities Having Jurisdiction at the Site.

F. Pre-installation Conference:
1. Prior to erection of cold-formed metal system components and associated Work, Contractor shall schedule and meet at the Site with installer of each component of associated Work, the installers of substrate construction to receive the cold-formed metal systems Work, the installers of other Work around cold-formed metal system that follows the cold-formed metal system Work, Engineer and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the cold-formed metal system Work, including but not necessarily limited to, the following:
   a. Review Project requirements and the Contract Documents.
   b. Review required submittals, both completed and yet to be completed.
   c. Review status of mock-ups.
   d. Review construction schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
   e. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
   f. Review procedures needed for protection of cold-formed metal systems during the remainder of the construction period.
   g. Review required inspection, testing, and certifying procedures.
2. Record the discussions of the conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
3. Record all revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.
4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.4 SUBMITTALS

A. Action Submittals:
1. Shop Drawings:

a. Detailed Shop Drawings for fabrication and erection showing in plan the location of products, elevations, and details for the cold-formed metal framing Work. Show all accessory items to provide a complete installation; reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work. Include details of all connections between all materials.
b. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.

2. Product Data:
a. Supplier's published literature for cold-formed metal framing proposed for each type of cold-formed metal framing product and accessory proposed.

B. Delegated Design Submittals:
1. Design Data: Submit the following:
a. Design Calculations:
1) Complete calculations for the cold-formed metal framing systems as one package with the Shop Drawings. Structural calculations shall include all specified performance criteria, required load cases and load combinations used in the design and resulting member forces, reactions, deflections, and other anticipated movements in the cold-formed metal framing system. The magnitude of reactions on supporting structures from all critical load combinations shall be tabulated separately. Critical load combinations used in the final sizing of members shall be emphasized. All calculations and assumptions shall be presented so that Engineer can easily follow the progress and logic of Contractor's professional engineer. The design analysis shall include the name and office phone number of the designer to answer questions during the shop drawing review.
2) Design calculations shall be signed, sealed, and dated by Contractor's professional engineer. State of professional engineer's registration, registration number, and name on seal shall be clearly legible.

C. Informational Submittals:
1. Certificates:
a. Certification by professional engineer that metal building system design is in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
b. Tests and Evaluation Reports:
1) Material test reports: From a qualified testing laboratory indicating and interpreting material test results of cold-formed metal framing system components, for compliance with requirements specified, including but not limited to:
a) Steel sheet
b) Mechanical fasteners
c) Power-actuated fasteners
d) Vertical deflection clips.
e) Horizontal drift deflection clips
f) Structural clips and accessories
2) Research/Evaluation Reports: For cold-formed metal framing.
2. Manufacturer's instructions:
a. Indicate preparation requirements and assembly sequence.
b. Installation data.

3. Qualification Statements:
    a. Manufacturer
    b. Professional Engineer
    c. Installer
    d. Testing Laboratory
    e. Welders and welding processes

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System description, general:
1. Cold-formed metal systems include complete, integrated sets of components and assemblies capable of withstanding structural and other loadings and thermally induced movements, without failure. The system includes all components necessary to complete the Work in a manner that provides a completely functioning system, complying with requirements shown and specified, all requirements of manufacturer, and governing authorities having jurisdiction at the Site.
2. Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
3. In some cases, incidental accessories necessary to the proper functioning of the specified system may not be mentioned in the Specifications. Contractor shall follow the recommendations of the approved manufacturer and provide systems and components with all required incidental accessories and component items necessary for the proper functioning of the systems, at no additional expense to Owner. Provide materials matching the specified material and finish of similar items.
4. Provide specified material gages, or heavier gages, if calculations based on performance criteria indicate the need for heavier gage material. Where compliance with performance criteria indicates that materials of lesser gage, or size, may be adequate, provide specified gages and sizes as minimum acceptable standard.
5. Requirements for interior, non-load bearing, metal stud framing are in Section 09 2216, Non-Structural Metal Framing.

B. Design Criteria:
1. Provide cold-formed metal framing systems capable of withstanding controlling effects of gravity and lateral loads per the basic load and load combinations in accordance with Laws and Regulations. Comply with 2017 Ohio Building Code, ASCE 7, applicable AISI standards, specifications, and publications, except to the extent more stringent requirements are specified or required by governing authorities having jurisdiction at the Site.
2. Design Loads:

a. As indicated in the Drawings and in accordance with all governing building codes.
b. Site specific load factors for Snow, Wind and Seismic loads are indicated in the Contract Drawings.

3. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Exterior wall framing or framing supporting masonry: Horizontal deflection of 1/600 of the wall height.
   b. Design exterior wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide cold-formed metal framing by one of the following:
   1. ClarkDietrich
   2. Or equal.

2.3 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
   1. Grade: Minimum ST33H; 33,000 ksi or as required by structural performance.
   2. Coating: G60.

2.4 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0538 inch.
   2. Flange Width: Minimum 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0538 inch**.**
   2. Flange Width: Manufacturer standard.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0538 inch.
   2. Flange Width: 1-5/8 inches.

2.5 NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0428 inch.
   2. Flange Width: 1-3/8 inches.
   3. Depth: As required by manufacturer design and as indicated in the Drawings.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.
2. Flange Width: Manufacturer standard.

C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: 1 inch plus the design gap where applicable.

E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure.

2.6 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Gusset plates.
7. Stud kickers, knee braces, and girts.
8. End closures.
9. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Expansion Anchors: Refer to Specification Section 05 0533, Anchor Systems.

C. Power-Actuated Fasteners: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E1190 conducted by a qualified independent testing agency.

D. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20, ASTM A780.

B. Shims: Load bearing, high-density multimonomer plastic, nonleaching.

2.9 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
   4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 7, in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
   1. Anchor Spacing: To match stud spacing.

B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
   1. Stud Spacing: 12 inches, or as required to coordinate and align with masonry and stone anchors.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
   1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
   2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
   1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced 48 inches or as indicated in the Drawings**.** Fasten at each stud intersection.
   1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of 2 screws into each flange of the clip angle for framing members up to 6 inches deep.
   2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

3. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
1. Stud Spacing: 16 inches, maximum, or as required to coordinate and align with masonry and stone anchors.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
1. Install single-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to studs and anchor to building structure.
4. Connect drift clips to cold formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
   a. Install solid blocking at 96-inch or as required by manufacturer design.
2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
4. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.6 FIELD QUALITY CONTROL

A. Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Engineer.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 4000

SECTION 05 5013

MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish miscellaneous metal fabrications including surface preparation and shop priming.
   2. The Work also includes:
      a. Providing openings in miscellaneous metal fabrications to accommodate the Work under this and other Sections, and attaching to miscellaneous metal fabrications all items such as sleeves, bands, studs, fasteners, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the Work to be installed with, or attached to miscellaneous metal fabrications Work.
   2. Hot-dip Galvanizing: Coordinate with steel fabricator detailing for and fabrication of assemblies to be hot-dip galvanized, to minimize distortion during galvanizing process.

C. Related Sections:
   1. Section 03 6000, Grouting.
   2. Section 05 0533, Anchor Systems.
   3. Section 05 5215, Aluminum Handrails and Railings.
   4. Section 05 5316, Aluminum Grating.
   5. Section 09 9100, Painting,

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI A14.3, Ladders – Fixed –Safety Requirements.
   2. ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
   3. ASTM A36/A36M, Specification for Carbon Structural Steel.
   4. ASTM A53/A53M, Specification for Pipe Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   5. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   6. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
   8. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
   9. ASTM A384/A384M-02 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.

10. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
12. ASTM A786/A786M, Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
13. ASTM A793, Specification for Rolled Floor Plate, Stainless Steel.
14. ASTM A992/A992M, Specification for Structural Steel Shapes.
15. ASTM A1085/A1085M, Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
16. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
17. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.
18. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
19. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
20. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
21. ASTM B632/B632M, Specification for Aluminum-Alloy Rolled Tread Plate.
22. AWS D1.1/D1.1M, Structural Welding Code – Steel.
23. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.
24. AWS D1.6, Structural Welding Code – Stainless Steel.
25. NAAMM, Metal Finishes Manual.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Welding:
      a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, D1.2/D1.2M, or D1.6, as applicable.
      b. When requested by Engineer, provide certification that each welder employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Regulatory Requirements: Conform to the following:
   1. 29 CFR 1910, Occupational Health and Safety Standards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and erection details for assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for locating and installing miscellaneous metal items and anchorage devices.
   2. Product Data:
      a. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.

B. Informational Submittals: Submit the following:
   1. Test and Evaluation Reports:

a. Mill test report that indicate chemical and physical properties of each type of material, when requested by Engineer.

2. Qualifications Statements:
   a. Copies of welder's certifications, when requested by Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in other construction in ample time to prevent delaying the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel:
   1. W-Shapes and WT-Shapes: ASTM A992/A992M.
   2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
   3. Hollow Structural Sections: ASTM A1085 or ASTM A500/A500M, Grade C.
   4. Angles, Plates, Bars: ASTM A36/A36M.
   5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Aluminum:
   1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
   2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
   3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
   4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

C. Stainless Steel:
   1. Plates and Sheets: ASTM A240/A240M, Type 304L or Type 316 stainless steel.
   2. Submerged or Intermittently Submerged: Type 316 stainless steel.
   3. Non-submerged: Type 304L stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 304L or Type 316 Stainless Steel.

E. Zinc-coated Hardware: ASTM A153/A153M.

2.2 MISCELLANEOUS METAL ITEMS

A. Shop Assembly:
   1. Pre-assemble items in the shop to the greatest extent possible to minimize field-splicing and field-assembly of units at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Aluminum Ladders:
   1. Fabricate ladders for locations shown or indicated with dimensions, spacing, details, and anchorages as shown and specified. Comply with OSHA 29 CFR 1910 and ANSI A14.3, except as otherwise shown or specified.

a. Unless otherwise shown, provide 1.5-inch diameter continuous side rails, spaced at least 1.5 feet apart.
b. Provide extruded square rungs, spaced maximum of 12 inches on centers, with non-slip surface on top of each rung. Adhesive strips for non-slip surfaces are not acceptable.

2. Fit rungs in centerline of side rails, plug weld, and grind smooth on outer rail faces.
3. Support each ladder at top and bottom and at intermediate points spaced not more than five feet on centers.
4. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold ladder clear of wall surface with minimum of seven inches between wall and centerline of rungs.
5. Unless otherwise shown or approved by ENGINEER, extend rails 3.5 feet above top rung, and return rails to wall or structure, unless other secure handholds are provided. If adjacent structure does not extend above top rung, goose-neck extended rails back to structure to provide secure ladder access.
   Use extruded aluminum conforming to alloy and temper 6061-T6.

C. Safety Post:
1. Provide safety post for each fixed access ladder located below an access hatch. Safety post shall be manufactured of high-strength structural material with telescoping tubular section that locks automatically when fully extended.
2. Products and Manufacturers: Provide products of one of the following:
   a. LadderUP Safety Post by Bilco Company
   b. Or equal.
3. Use upward and downward movement of post shall be controlled by stainless steel spring balancing mechanism.
4. Safety post shall be hot-dip galvanized steel.

D. Steel Lintels:
1. Provide loose structural steel lintels for openings and recesses in masonry walls and brick walls as specified or as shown.
2. Weld adjoining members together to form a single unit, where shown or indicated.
3. Provide not less than eight inches bearing at each side of openings, unless otherwise shown.
4. Steel lintels to be installed in exterior walls shall be hot-dip galvanized and finish painted. Other steel lintels shall be painted.
5. Surface preparation and painting shall conform to Section 09 9100, Painting.
6. Where lintels are not shown on the Drawings, provide lintels as specified in the following table. Provide other lintels where shown and of size indicated on the Drawings.

Clear Span (Max)	Exterior Angle	Interior Angles (typical 8-inch wall)
4.0 feet	3.5 inches by 3.5 inches by 5/16 inches	Two 3.5 inches by 3.5 inches by 5/16 inches
6.0 feet	Four inches by 3.5-inches by 5/16 inches	Two 4 inches by 3.5 inches by 5/16 inches
8.0 feet	Five inches by 3.5 inches by 5/16 inches	Two 5 inches by 3.5 inches by 5/16 inches

E. Shelf Angles:
   1. Provide structural steel shelf angles of sizes shown, for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than six inches from ends and not more than 2.0 feet on centers, unless otherwise shown.
      a. Provide galvanized shelf angles on outdoor construction.
   2. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.

F. Aluminum Stair Nosings:
   1. Manufacturers: Provide products of one of the following:
      a. Supergrit Type 241BF by Wooster Products, Inc.
      b. Or equal.
   2. Fabricate extruded aluminum nosing of sizes and configurations as shown on the Drawings.
      a. Unless otherwise shown, provide ribbed abrasive filled type, using black abrasive filler.
   3. Provide anchors for embedding in concrete, either integral or applied to treads, as standard with manufacturer.

G. Bollards:
   1. Provide Schedule 80 galvanized steel pipe filled with concrete as shown on the Drawings. Paint as required in accordance ith Section 09 9100, Painting. Unless otherwise shown or specified, finish-paint bollard “Safety Yellow.”

H. Miscellaneous Framing and Supports:
   1. Provide miscellaneous metal framing and supports that are not part of structural steel or aluminum framework and are required to complete the Work.
   2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings or, if not shown, of required dimensions to receive adjacent grating, plates, tanks, doors, and other work to be retained by the framing.
   3. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
   4. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
   5. Furnish units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units are to be installed after concrete is placed.
      a. Except as otherwise shown, space anchors, 2.0 feet on centers, and provide units the equivalent of 1.25-inch by 1/4-inch by eight-inch strips.
      b. Galvanize exterior miscellaneous frames and supports.
      c. Where shown or indicated, galvanize miscellaneous frames and supports that are not to be installed outdoors.
   6. Miscellaneous steel framing and supports shall be hot-dip galvanized and finish-painted, unless otherwise shown or indicated.
   7. For railings, refer to Section 05 5215, Aluminum Handrails and Railing.
   8. For grating requirements refer to Section 05 5316, Aluminum Grating.
   9. Surface preparation and painting of galvanized surface shall conform to Section 09 9100, Painting

I. Steel Raised-pattern Floor Plate:
   1. Provide raised-pattern floor plate conforming to ASTM A786/A786M and manufacturer’s standards. Plates shall be of thicknesses shown.
   2. Products and Manufacturers: Provide products of one of the following:

a. 4-Way Safety Steel Plate, by Ryerson Tull Company.
b. Raised Pattern Steel Floor Plate, by Central Steel and Wire Company.
c. Or equal.

3. Provide removable plates at locations and sizes shown. Provide perforated plates where shown.
4. Provide each plate section with four lifting handles as recommended by manufacturer. Lifting handles shall be recessed, drop handle type. Maximum weight of checkered plate or plank section shall be 150 pounds.
5. Finish: Hot-dip galvanize in accordance with ASTM A123/A123M.

J. Hurricane Tie Down:
1. Product and Manufacturer:
a. Seismic/Hurricane Tie H3 by Simpson Strong Tie
b. Or Equal.
2. Minimum 18-gage hot dip galvanized steel connector with hot dip galvanized or stainless steel fasteners. Fasteners shall be as recommended per approved tie manufacturer for the maximum tabulated loads.

K. Fasteners and Hardware: Provide Type 316 stainless steel fasteners for aluminum fabrications and zinc-coated hardware for galvanized fabrications, unless otherwise shown or specified.

L. Anchors and Expansion Anchors: Refer to Section 05 0533, Anchor Systems.

2.3 FINISHING

A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to miscellaneous metal fabrications in the shop. Conform to surface preparation and shop priming requirements in Section 09 9100, Painting.

B. Galvanizing:
1. Galvanizing of fabricated steel items shall comply with ASTM A123/A123M.
2. Details of fabrication of steel items and assemblies to be hot-dip galvanized shall conform to recommendations of ASTM A384/A384M to minimize the potential for distortion.

C. Aluminum Finish: Provide natural mill finish for aluminum Work unless otherwise shown or specified.

2.4 SOURCE QUALITY CONTROL

A. Tests and Inspections:
1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures complying with the Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions under which the Work is to be performed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install miscellaneous metal fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.

B. Anchor securely as shown and as required for the intended use, using concealed anchors where possible.

C. Manufactured items:
   1. Strictly follow all manufacturer's printed installation instructions.

D. Fit exposed connections accurately together to form tight, hairline joints. Field-weld steel connections that are not to be exposed joints and cannot be shop-welded because of shipping size limitations. Comply with AWS D1.1/D1.1M, D1.2/D1.2M and D1.6, as applicable to the material being welded. Grind steel joints smooth and touch-up shop paint coat. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

E. Protection of Aluminum from Dissimilar Materials:
   1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 9100, Painting.

END OF SECTION 05 5013

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SECTION 05 5215

ALUMINUM HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install aluminum handrail and railing systems. The Work also includes:
   a. Providing openings in, and attachments to, aluminum handrail and railing systems to accommodate the Work under this and other Specification Sections. Provide all items for aluminum handrails and railings, including anchorages, fasteners, studs, and other items required for which provision for is not specifically included under other Sections.
   b. Provide openings in and attachments to aluminum handrails and railings to accommodate work under other contracts. Assist other contractors in building on or attaching to aluminum handrails and railings all items such as fasteners and other items required for which provision is not specifically included under other contracts.
2. Aluminum handrails and railings Work shall include components and features shown and specified, and all components and features available from specified manufacturers required for providing complete aluminum handrail and railing system in accordance with the Contract Documents.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before aluminum handrails and railings Work.
2. Aluminum handrail and railing locations shall comply with Laws and Regulations.

C. Related Sections:
1. Section 03 6000, Grouting.
2. Section 05 0533, Anchor Systems.
3. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
1. AA, Aluminum Design Manual.
2. ASTM B26/B26M, Specification for Aluminum-Alloy Sand Castings.
3. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
4. ASTM B136, Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum.
5. ASTM B137, Standard Test Method for Measurement of Coating Mass per Unit Area on Anodically Coated Aluminum.
6. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
7. ASTM B241/B241M, Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.

8. ASTM B244, Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments.
9. ASTM B247, Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and rolled Ring Forgings.
10. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
11. ASTM E 935, Standard Test Methods for Permanent Metal Railing Systems and Rails for Buildings.
12. NAAMM/Architectural Metal Products Division (AMP), Pipe Railing Manual.
13. NAAMM/AMP AMP 501 Finishes for Aluminum.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer:
   a. Upon request manufacturer shall submit document at least five years successful experience in fabricating aluminum handrail and railing systems of scope and type similar to that required.
   b. Manufacturer shall be capable of providing custom detail drawings for the products required.
2. Professional Engineer:
   a. Contractor or handrail and railing manufacturer shall retain a registered professional engineer legally qualified to practice in same state as the Site. Professional engineer shall have at least five years experience designing aluminum handrails and railings.
   b. Responsibilities include:
      1) Reviewing aluminum handrail and railing system performance and design criteria stated in the Contract Documents.
      2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
      3) Preparing or supervising preparation of design calculations verifying compliance of aluminum handrail and railing system with requirements of the Contract Documents.
      4) Signing and sealing all calculations.
      5) Certifying that:
         a) Design of aluminum handrail and railing system was performed in accordance with performance and design criteria stated in the Contract Documents, and
         b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
3. Installer:
   a. Retain a single installer trained and with record of successful experience in installing aluminum handrail and railing systems.
   b. Installer shall have record of successfully installing aluminum handrail and railing systems in accordance with recommendations and requirements of manufacturer, or shall provide evidence of being acceptable to the manufacturer.
   c. Installer shall employ only tradesmen with specific skill and successful experience in the type of Work required.
   d. When requested by Engineer, submit name and qualifications of installer with the following information for at least three successful, completed projects:
      1) Names and telephone numbers of owner and architect or engineer responsible for each project.

2) Approximate contract cost of the aluminum handrail and railing systems for which installer was responsible.
3) Amount (linear feet) of aluminum handrail and railing installed.

B. Component Supply and Compatibility:
1. Obtain all materials furnished under this Section regardless of component manufacturer, from a single aluminum handrail and railing system manufacturer.
2. Aluminum handrail and railing system manufacturer shall review and approve or prepare all Shop Drawings and other submittals (except for delegated design submittals, when professional engineer is retained by other than handrail and railing manufacturer) for all components furnished under this Section.
3. Components shall be specifically constructed for specified service conditions and shall be integrated into overall assembly by aluminum handrails and railings manufacturer.

C. Regulatory Requirements: Comply with Laws and Regulations including:
1. OSHA Part 1910.23, Guarding Floor and Wall Openings and Holes.

D. Certifications:
1. Submit certification, signed by authorized officer of manufacturer and notarized, stating that handrail and railing systems comply with the design prepared by the professional engineer.
2. Submit certification, signed by authorized officer of Contractor and notarized, stating that all components and fittings are furnished by the same manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Drawings for fabrication and installation of aluminum handrail and railing systems with sizes of members, pipe wall thickness, information on components, and anchorage devices. Show all anchorages. Provide details drawn at scale of 1.5-inch equal to one foot.
b. Indicate required location of posts.
c. Indicate locations and details of all expansion joints, if any.
d. Indicate locations and details of gaps across seismic joints, if any.
e. Profile drawings of aluminum handrail and railing system components.
f. Custom detail drawings. Details of forming, jointing, sections, connections, internal supports, trim and accessories. Provide details drawn at scale of 1.5-inch equal to one foot.
2. Product Data:
a. Manufacturer's specifications, standard detail drawings, and installation instructions for aluminum handrail and railing systems.
b. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by Engineer.
3. Delegated Design Submittals:
a. Design Data:
1) Design computations or complete structural analysis of handrail and railing systems, signed and sealed by professional engineer. Professional engineer's seal shall be clearly legible, including state of registration, registration number, and name on seal.

2) Certification by professional engineer that professional engineer has performed design of aluminum handrail and railing systems in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to all local, state, and federal Laws and Regulations, and to prevailing standards of practice.

4. Samples:
   a. Full-size Sample, two feet long, of assembled railing system at post and rail intersections. Sample shall have all associated components including typical connections, mounted toeboard and sleeve, and handrail at wall return, complete with mounting brackets, all with specified controlled uniform metal finish.
   b. Color Samples: Maximum range of clear anodized aluminum that shall appear in finished Work. Prepare range Samples, to show highest level of color control feasible for actual handrail and railing systems, as determined by licensor of finishing process specified, on actual extrusions and castings of the Work.
   c. Engineer will review Samples for finish, color, joint tolerances, workmanship, and general component assembly only. Compliance with other requirements is the responsibility of the Contractor.
5. Test Procedure: Submit detailed description of proposed shop testing procedures. Do not perform shop testing until Engineer approves shop test procedure:

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certification on source of supply, as specified in Article 1.3 of this Section.
      b. Manufacturer certification specified in Article 1.3 of this Section.
   2. Source Quality Control Submittals:
      a. Manufacturer's load testing report in accordance with ASTM E935 for completed aluminum handrail and railing systems, demonstrating compliance with applicable requirements of building codes, safety codes, and other Laws and Regulations.
   3. Qualifications Statements: Submit qualifications for the following:
      a. Manufacturer, when requested by Engineer.
      b. Professional engineer.
      c. Installer, when requested by Engineer. Qualifications statement shall include record of experience with references specified.

C. Closeout Submittals: Submit the following:
   1. Maintenance Manuals: Furnish detailed maintenance manuals that include the following:
      a. Product name and number.
      b. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods and precautions in use of products that may be detrimental to finish when improperly applied.
      c. Handrail and railings systems manufacturer's current catalog including individual parts.
      d. Maintenance manuals shall be in accordance with Section 01 7823, Operations and Maintenance Data.
   2. Guarantee: Provide in maintenance manual the guarantee specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Keep products off ground using pallets, platforms, or other supports. Protect products from corrosion and deterioration.

B. Handling of Products:
   1. Do not subject handrail and railing products to bending or stress.
   2. Do not damage edges or handle products in a manner that will cause scratches, warping, or dents.
   3. Protect handrails and railings by paper or coating as acceptable to handrail and railing manufacturer, against scratching, splashes of mortar, paint, and other marring during transportation, handling, and erection. Protect until completion of adjacent work.

1.6 GUARANTEE

A. Guarantee: Manufacturer shall provide written guarantee of availability of replacement parts and components for period of at least five years after completion of the Project.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description: Aluminum handrail and railing system shall consist of equally spaced horizontal rails with totally concealed mechanical fasteners, internally threaded tubular rivets and components fastened to posts spaced no more than five feet on centers and system of handrails supported from adjacent construction by mounting brackets spaced at no more than five feet on centers.

B. Design Criteria and Performance Criteria:
   1. Design, fabricate, and install aluminum handrail and railing systems to withstand the most critical effects resulting from the following loads (loads listed below do not act concurrently):
      a. Uniform Load: 50 pounds per foot, applied at top in any direction.
      b. Concentrated Load: 200 pounds single load, applied at any point along the top in any direction.
      c. Components: Intermediate rails (all rails except the handrail), balusters, and panel fillers, if any, shall withstand horizontally-applied normal load of 50 pounds on an area equal to one square foot, including openings and space between rails. Reactions due to this loading are not required to be superimposed to loading specified for main supporting members of handrails and railings.
      d. Comply with AA Aluminum Design Manual for determining allowable stresses and safety factors for aluminum structural components.
      e. Limit deflection in each single span of railing and handrail to 1.5-inch maximum, and to 1/4-inch maximum on railing posts. Applied loads shall not produce permanent deflection in the completed Work when loads are removed.
   2. Thermal Control: Provide adequate expansion within fabricated systems that allows for thermal expansion and contraction caused by material temperature change of 140 degrees F to -20 degrees F without warp or bow of system components. Distance between expansion joints shall be based on providing 1/4-inch wide joint at 70 degrees F, which accommodates movement of 150 percent of calculated amount of movement for specified temperature range.
   3. Where handrail and railing systems cross expansion joints in the building or structure, provide expansion joints in handrail and railings systems.
   4. For posts located at or near end of runs as shown, uniformly space intermediate posts as required to conform to loading and deflection criteria specified, at intervals no greater than maximum post spacing specified. Where posts are shown for handrails along both sides of

walkways and other similar locations, locate posts opposite each other; do not stagger post locations.

2.2 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:
   1. Wesrail, by Moultrie Manufacturing Company.
   2. Alumaguard, by Alumaguard – A division of Bettinger West, Inc.
   3. Or equal.

2.3 MATERIALS

A. Extruded Aluminum Architectural and Ornamental Shapes: ASTM B221, Alloy 6063-T52.

B. Aluminum Forgings: ASTM B247.

C. Extruded or Drawn Aluminum Pipe and Tube:
   1. ASTM B429 or ASTM B241/B241M, Alloy 6063-T5, 6063-T52, or 6063-T832 as required by loadings, deflections, and post spacing specified.
   2. Provide Schedule 40 pipe, minimum, unless conditions of detail and fabrication require extra-heavy pipe to comply with Specifications. Rails and posts shall have minimum outside diameter of 1.90 inches.

D. Reinforcing Bars: Urethane foam-filled, Schedule 80, 23 inches long 6061-T6 aluminum reinforcing bars or tubes with outside diameter same as inside diameter of post.

E. Anchors and Fastenings:
   1. For anchors and fasteners, use Type 316 stainless steel; minimum 3/8-inch diameter.
   2. Provide minimum of four bolt fasteners per post where surface-mounted posts are shown. Components shall be in accordance with manufacturer's recommendations and as approved or accepted (as applicable) by Engineer on submittals.
   3. Anchors: In accordance with Section 05 0533, Anchor Systems.

F. Castings:
   1. Provide high-strength aluminum alloy brackets, flanges, and fittings suitable for anodizing as specified.
   2. Aluminum alloy sand castings: ASTM B26/B26M.

G. Brackets and Flanges:
   1. Provide manufacturer's complete selection of standard and custom brackets and flanges for railing system posts and for handrail supports.

H. Connector Sleeves: Schedule 40, five-inch long by 1.610-inch diameter.

I. Sockets: Provide six-inch deep by 2.5-inch outside diameter aluminum sockets with 3.5-inch wide socket cover on bottom of each socket and on top and bottom of removable post sockets.

J. Gates: For each gate in handrail or railing system, provide the following:
   1. Hinges: Two-self closing aluminum hinges.
   2. Latches and Stops: One latch and stop with rubber bumper and one-inch diameter plastic knobs.

K. Custom Cover Flanges: 1/4-inch high by four-inch diameter, aluminum.

L. Adhesive: Two-part waterproof epoxy-type as recommended by handrail and railing systems manufacturer.

M. Non-shrink Grout: Comply with Section 03 6000, Grouting.

N. Toeboards:
1. Provide extruded Alloy 6063-T5 or T52 aluminum alloy toeboards, unless railing is mounted on curbs or other construction of sufficient height and type to comply with OSHA 1910.23. Bars or plates are not acceptable.
2. Unless otherwise specified, toeboards shall comply with OSHA 1910.23, Section (e).

O. System Components and Miscellaneous Accessories: Provide complete selection of manufacturer's standard and custom aluminum handrail and railing systems components and miscellaneous accessories required. Show type and location of all such items on Shop Drawings and other submittals as applicable.

2.4 FABRICATION

A. General: Unless otherwise shown or specified, provide typical non-welded construction details and fabrication techniques recommended in NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501.

B. Fabricate handrail and railing systems true to line and level, with accurate angles surfaces and straight edges. Fabricate corners without using fittings. Provide bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces, or use prefabricated bends. Provide not less than four-inch outside radius.

C. Remove burrs from exposed edges.

D. Close aluminum pipe ends by using prefabricated fittings.

E. Weep Holes:
1. Fabricate joints that will be exposed to weather to exclude water.
2. Provide 15/64-inch diameter weep holes at lowest possible point on each post in handrail and railing systems.
3. Provide pressure relief holes at closed ends of handrail and railing systems.

F. Toeboards:
1. Provide manufacturer's standard toeboard, that accommodates movement caused by thermal change specified without warping or bowing toeboards.
2. Provide manufacturer's standard toeboard, which accommodates storage for removable socket covers.
3. Coordinate and cope toeboard as required to accommodate cover flanges at posts.
4. Toeboards shall follow curvature of railing. Where railing is shown to have curved contours at corners, or other locations, toeboard shall likewise be curved to follow line of railing system.

G. Reinforcing Bars: Provide reinforcing bar friction-fitted at each post in railing system. Extend reinforcing bars of tubes six inches into cast-in-place sleeves or other types of supporting brackets.

H. Mechanically Fitted Component Pipe Handrail and Railing System:
1. Use non-welded pipe handrail and railing system with posts, top and intermediate rail(s), and flush joints.
2. Provide top and one intermediate horizontal rail, equally spaced.
3. Use Type 304/305 stainless steel blind rivets and Type 304/305 stainless steel self-tapping screws in assembling components of the Work.

2.5 FINISHES

A. General:
1. Prepare surfaces for finishing in accordance with recommendation of aluminum producer and the aluminum finisher or processor.
2. Adjust and control direction of mechanical finishes specified to achieve best overall visual effect in the Work.
3. Color and Texture Tolerance: Provide uniform color and continuous mechanical texture for aluminum components. Engineer reserves the right to reject aluminum materials because of color or texture variations that are visually objectionable, but only where variation exceed range of variations established by manufacturer prior to fabrication, by means of range of Samples approved by Engineer.
4. Anodize aluminum components.

B. Finish:
1. Mechanically finish aluminum by wheel or belt polishing with aluminum oxide grit of 180 to 220 size, using peripheral wheel speed of 6,000 feet per minute; AA Designation - M32 Medium Satin Directional Texture.
2. Hand-Rubbed Finish: Where required to complete the Work and provide uniform, continuous texture, provide hand-rubbed finish to match medium satin directional texture specified to even out and blend satin finishes produced by other means.

C. Cleaning:
1. Provide non-etching chemical cleaning by immersing aluminum in inhibited chemical solution, as recommended by coating applicator, to remove lard oil, fats, mineral grease, and other contamination detrimental to providing specified finishes.
2. Clean and rinse with water between steps as recommended by aluminum manufacturer.

D. Exposed Aluminum Anodic Coating: Provide anodic coatings as specified that do not depend on dyes, organic or inorganic pigments, or impregnation processes to obtain color. Apply coatings using only the alloy, temperature, current density, and acid electrolytes to obtain specified colors in compliance with designation system and requirements of NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501. Comply with the following:
1. Provide Architectural Class I high density anodic treatment by immersing the components in tank containing solution of 15 percent sulfuric acid at 70 degrees F with 12 amperes per square foot of direct current for minimum of sixty minutes; AA Designation A41 Clear .
2. Physical Properties:
a. Anodic Coating Thickness, ASTM B244: Minimum of 0.7-mils thick.
b. Anodic Coating Weight, ASTM B137: Minimum of 32 mg/sq. in.

c. Resistance to Staining, ASTM B136: No stain after five minutes dye solution exposure.
d. Salt Spray, ASTM B117: 30,000 hours exposure with no corrosion or shade change.

3. Seal finished anodized coatings using deionized boiling water to seal pores and prevent further absorption.
4. Products and Manufacturers: Provide one of the following:
   a. Alumilite 215 Clear by Aluminum Company of America, Inc.
   b. Or equal.

2.6 SOURCE QUALITY CONTROL

A. Allowable Tolerances:
1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
   a. Spacing: Plus-or-minus 3/8-inch.
   b. Alignment: Plus-or-minus 1/4-inch.
   c. Plumbness: Plus-or-minus 1/8-inch.
2. Minimum Handrails and Railings Systems Plumb Criteria:
   a. Limit variation of completed handrail and railing system alignment to 1/4-inch in 12 feet with posts set plumb to within 1/16-inch in 3.0 feet.
   b. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12.0 feet.
3. Provide “pencil-line” thin butt joints.

B. Factory Testing:
1. Perform load test on completed handrail and railing systems. Extent of handrail and railing systems to be factory-tested shall be as shown and specified.
2. Load test completed handrail and railing systems in accordance with requirements of ASTM E935. Provide written report to Engineer identifying and documenting testing methods used, magnitude and location of loads superimposed, and results of such tests on actual completed handrail and railing systems, including all anchors and fasteners to be used in the Work. Testing setup shall simulate actual conditions of installation to be used in the Work.
3. Do not ship products from factory until Engineer accepts load testing report.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work will be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Verify to Engineer the gage of aluminum pipe railing posts and rails brought to the Site by actual measurement of on-Site material in presence of Engineer.

3.2 INSTALLATION

A. General:
1. Do not erect components that are scarred, dented, chipped, discolored, otherwise damaged, or defaced. Remove from Site railing and handrail system components that have holes,

cuts, gouges, deep scratches, or dents of any kind. Repairs to correct such Work will not be accepted. Remove and replace with new material.

2. Comply with installation and anchorage recommendations of NAAMM/AMP Pipe Railing Manual and NAAMM/AMP AMP 501 in addition to requirements specified and approved or accepted (as applicable) submittals.

B. Fastening to In-Place Construction:

1. Remove protective plastic immediately before installing.
2. Adjust handrails and railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction. Secure posts and rail ends to building or structure as follows:
   a. Anchor posts in concrete by providing sockets set and anchored into concrete floor slab. Provide closure secured to bottom of sleeve. Before installing posts, remove debris and water from sleeves. Verify that reinforcing bars or tubes have been inserted into posts before installation. Do not install posts without reinforcing bar. For all non-removable handrail and railing systems sections, after posts have been inserted into sockets, fill annular space between posts and sockets solid with grout as specified in Section 03 6000, Grouting. Crown the grout and slope grout to drain away from posts.
   b. Anchor posts to stair stringers with stringer or support flanges, angle type or floor type as required by conditions, shop-connected to posts and bolted to steel supporting members. Flanges shall be as recommended by manufacturer. Verify that reinforcing bars are inserted into posts before installation. Do not install posts without reinforcing bar.
   c. Side-mount posts by fastening them securely in brackets attached to steel or concrete fascia as shown and in accordance with approved or accepted (as applicable) submittals.
   d. Provide posts set in concrete with an aluminum floor cover flange.
3. Use devices and fasteners recommended by handrail and railing systems manufacturer and as shown on approved or accepted (as applicable) submittals.

C. Cutting, Fitting, and Placement:

1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels.
2. Fit exposed connections accurately together to form tight hairline joints. Do not cut or abrade surfaces of units that have been finished after fabrication, and are intended for field connections.
3. Make permanent field splice connections using stainless steel blind rivets and five-inch minimum length connector sleeves. Tight press-fit field splice connectors and install in accordance with manufacturer's written instruction. Install two blind rivets per joint on 180-degree centers.
4. Make splices as near as possible to posts, but not exceeding 12 inches from nearest post.
5. Field welding is not allowed. Make splices using pipe splice lock employing a single allen screw to lock joint.
6. Secure handrails to walls with wall brackets and end fittings as shown. Drill wall plate portion of the bracket to receive one bolt, unless otherwise shown for concealed anchorage. Locate brackets as shown or, if not shown, at not more than five feet on centers. Provide flush type wall return fittings with same projection shown for wall brackets. Secure wall brackets and wall return fittings to building or structure. Refer to Section 05 0533, Anchor Systems.

7. Securely fasten toeboards in place with not more than 1/4-inch clearance above floor level.
8. Drill one 15/64-inch diameter weep hole not more than 1/4-inch above top of location of solid reinforcing bar or tube in each post.

D. Expansion Joints:
1. Provide slip joint with internal sleeve extending not less than two inches beyond joint on each side.
2. Construct expansion joints as for field splices, except fasten internal sleeve securely to one side of rail only.
3. Locate joints within six inches of posts.

E. Protection from Dissimilar Materials:
1. Coat aluminum surfaces in contact with dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 9100, Painting.
2. Do not extend coating beyond contact surfaces. Remove coating where exposed-to-view in the finished Work.

3.3 CLEANING AND REPAIRING

A. Cleaning:
1. Clean exposed surfaces of handrail and railing systems after completion of installation. Comply with recommendations of both handrail and railing system manufacturer and finish manufacturer. Do not use abrasives or unacceptable solvent cleaners. Test cleaning techniques on an unused section of railing before employing cleaning technique.
2. Remove stains, dirt, grease, and other substances by washing handrails and railings systems thoroughly using clean water and soap; rinse with clean water.
3. Do not use acid solution, steel wool, or other harsh abrasives.
4. If stain remains after washing, remove defective sections and replace with new material complying with this Section.

B. Handrails and railings shall be free of dents, burrs, scratches, holes, and other blemishes. Replace damaged or otherwise defective Work with new material that complies with this Section at no additional cost to Owner.

C. Prior to Substantial Completion, replace adjacent work marred by the Work of this Section.

END OF SECTION 05 5215

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SECTION 05 5311

STEEL GRATING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install steel grating and frames.
2. The Work includes:
a. Providing grating, frames, and appurtenances.
b. Providing openings in grating to accommodate the Work under this and other Sections and attaching to steel grating all items such as sleeves, bands, studs, fasteners, and items required for which provision is not specifically included under other Sections.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before steel grating Work.

C. Related Sections (Not Used)

1.2 REFERENCES

A. Standards referenced in this Section are:
1. ASTM A36/A36M, Specification for Carbon Structural Steel.
2. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
3. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
4. MS MIL-P-21035, Paint, High Zinc Dust Content Galvanizing Repair.
5. NAAMM MBG 531, Metal Bar Grating Manual.
6. NAAMM MBG 533, Welding Specifications for Fabrication of Steel, Aluminum and Stainless Bar Grating.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer: Shall have at least five years experience manufacturing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
1. Obtain all products included in this Section regardless of component manufacturer from a single steel grating manufacturer.
2. Steel grating manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by steel grating manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and erection of all steel gratings Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.
      b. Setting drawings and templates for location and installation of anchorage devices.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver products to the Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
   2. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
   1. Protect materials from corrosion and deterioration.
   2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Steel Grating: Provide steel grating complying with the following:
   1. Grating Design Loads: Uniform live load shall be as shown or indicated in the Contract Documents. Where live load is not shown or indicated, uniform live and concentrated loads shall be as indicated in the table below, whichever results in the greater design stresses.

	Live Load	**Concentrated Load**
a.	100 psf	500 lbs. per foot of grating width at center of span
b.	150 psf	750 lbs. per foot of grating width at center of span
c.	200 psf	1,000 lbs. per foot of grating width at center of span
d.	300 psf	1,500 lbs. per foot of grating width at center of span

   2. Maximum Clear Span Deflection for Uniform Live Loads: 1/120 of span, but not more than 1/4-inch.
   3. Maximum Fiber Stress: 18,000 psi.
   4. Minimum Size of Members:
      a. Minimum size of bearing bars shall be within standard mill tolerance of that indicated in load tables in NAAMM MBG 531 for applicable loading and deflection requirements.
      b. Minimum dimensions of cross bars shall be as indicated in the tables of Minimum Standard Cross Bars and Connecting Bars in NAAMM MBG 531.

5. Banding bar shall be 1/4-inch thick minimum. Top of banding bar shall be flush with top of grating unless otherwise shown or indicated. Banding bar shall be 1/4-inch shorter than bearing bar height.

2.2 MANUFACTURERS

A. Grating, Products and Manufacturers: Provide grating of one of the following:
   1. Weldforged, manufactured by IKG Industries.
   2. Light Duty Welded grating, manufactured by Ohio Gratings, Inc.
   3. Or equal.

2.3 MATERIALS

A. Hot rolled carbon steel sheet and strip bearing bars and cross bars shall comply with ASTM A1011/A1011M, Commercial Steel (CS Type 2).

B. Structural steel bearing bars and cross bars shall comply with ASTM A36/A36M.

C. Wire rod Cross Bars: ASTM A510, except that permissible tolerance on diameter of coarse round wire shall be plus-0.005-inch.

D. Frames: Steel complying with ASTM A36/A36M.

E. Galvanizing Repair Paint: High zinc-dust content paint for repairing damaged galvanized surfaces complying with MS MIL-P-21035.

2.4 FABRICATION

A. Use materials of minimum depth and thickness specified and as required to comply with performance criteria shown or indicated in the Contract Documents.

B. Provide grating as follows:
   1. Grating Type: Welded rectangular bearing bars with cross bars resistance-welded at right angles to bearing bars.
   2. Depth: One inch, minimum.
   3. Bearing Bars: Minimum one-inch by 3/16-inch spaced at 1-3/16-inch on centers.
   4. Cross Bars: Welded to bearing bars at maximum spacing of four inches on centers.
   5. Surface: Plain.
   6. Finish: Hot-dip galvanized.

C. Provide cutouts in grating for passage of piping, electrical conduit, valve stems, columns, ducts, and similar work. Where more than two bearings bars are included in a cut out, provide banding bars of same dimensions as bearing bars around opening welded to grating component parts.

E. Gratings shall be accurately fabricated, free from warps, twists, and other defects that would affect grating appearance or grating serviceability.

F. Tops of grating bearing bars and cross bars shall be in the same plane.

G. Welding shall comply with NAAMM MBG 533. Welds shall be ground smooth at top and bearing surfaces.

H. Openings in and edges of grating sections shall be banded with flat banding bars as specified in this Section, welded along the line of cutout or to end of grating panel.

I. Size each section of grating to weigh not more than 150 pounds, unless otherwise indicated in the Contract Documents.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions under which Work is to be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Check all dimensions at the Site after piping and equipment are in place and determine exact locations of openings and cutouts.

3.2 INSTALLATION

A. Fastening to In-Place Construction:
   1. Use anchorage devices and fasteners to secure steel grating to supporting members or prepared openings, as recommended by manufacturer.
   2. For steel grating having bearing bars at 1-3/16-inch on centers or greater, provide four saddle clip anchors designed to fit over two bearing bars, and four stud bolts with washers and nuts for each grating panel, unless otherwise shown or indicated in the Contract Documents. For bearing bars spacing less than 1-3/16-inch on centers, provide anchors in accordance with manufacturer's recommendations.

B. Cutting, Fitting, and Placing:
   1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true, and free of rack. Do not use wedges or shimming devices.
   2. Where grating is penetrated by piping, electrical conduit, ducts, structural members, or similar protrusions, cut openings neatly and accurately to size and attach banding bar as specified.
   3. Divide panels into sections only to extent required for installation where steel grating is to be installed around previously installed piping, electrical conduit, ducts, structural members, or similar protrusions.

C. Steel gratings in concrete floors shall be removable and shall be arranged in sizes to be readily lifted. Provide steel gratings in concrete with steel angle frames having mitered corners and welded joints. Grind exposed joints smooth. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected for flush fit.

D. Clearance at ends or between sections of steel grating shall be not more than 1/4-inch.

E. Tops of steel gratings shall be set flush with surrounding construction.

F. Steel gratings shall be set with full and uniform end bearing on frames to preclude rocking movement; do not use wedges or similar shimming devices.

G. Remove stains, cement droppings, oils, dirt, grease, paint, and other foreign matter.

H. Repair galvanized coating, damaged in the shop or during field erection, with galvanizing repair paint applied in accordance with the repair paint manufacturer's instructions and recommendations.

+ + END OF SECTION + +

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SECTION 05 5316

ALUMINUM GRATING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install aluminum grating and frames.
   2. The Work includes:
      a. Providing grating, frames, and appurtenances.
      b. Providing openings in aluminum grating to accommodate the Work under this and other Sections, and attaching to aluminum grating all items such as sleeves, bands, studs, fasteners, and items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before aluminum grating Work.

C. Related Sections:
   1. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AA Aluminum Design Manual.
   2. ASTM B210, Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
   3. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   4. NAAMM MBG 531, Metal Bar Grating Manual.
   5. NAAMM MBG 533, Welding Specifications for Fabrication of Steel, Aluminum and Stainless Steel Bar Grating.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have at least five years' experience manufacturing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all products and materials included in this Section regardless of component manufacturer from a single aluminum-grating manufacturer.
   2. Aluminum grating manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all products and materials furnished under this Section.
   3. Components shall be suitable for the specified service conditions and be integrated into overall assembly by aluminum grating manufacturer.

4. Provide only one type of aluminum grating exclusively throughout the Project.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and erection of all Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.
      b. Setting drawings and templates for location and installation of anchorage devices.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.
   3. Samples:
      a. Representative Samples of grating, appurtenances and other finished products requested by Engineer.
      b. Engineer'S review will be for type and finish only. Compliance with all other requirements is exclusive responsibility of Contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices to be embedded in cast-in-place concrete in ample time to prevent delaying the Work.
   2. Comply with Section 01 6500, Product Delivery Requirements.

B. Storage and Protection:
   1. Protect materials from corrosion and deterioration.
   2. Do not store materials in contact with concrete or other materials that might cause corrosion, staining, scratching, or damage materials or finish.
   3. Comply with Section 01 6600, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Aluminum Grating: Provide aluminum grating complying with the following:
   1. Grating Design Loads: Uniform live load shall be as shown or indicated in the Contract Documents. Where live load is not shown or indicated, uniform live and concentrated loads shall be as indicated in the table below, whichever results in the greater design stresses.

	Live Load	**Concentrated Load**
a.	100 psf	500 lbs. per foot of grating width at center of span
b.	150 psf	750 lbs. per foot of grating width at center of span
c.	200 psf	1,000 lbs. per foot of grating width at center of span
d.	300 psf	1,500 lbs. per foot of grating width at center of span

   2. Maximum Clear Span Deflection for Uniform Live Loads: 1/120 of span, but not more than 1/4-inch.

3. Maximum Fiber Stress: 12,000 psi.
4. Do not install aluminum grating in areas subject to vehicular traffic.
5. Minimum Size of Members:
    a. Minimum size of bearing bars shall be within standard mill tolerance as indicated in load tables in NAAMM MBG 531 for applicable loading and deflection requirements.
    b. Minimum dimensions of cross bars shall be as indicated in tables of Minimum Standard Cross Bars and Connecting Bars in NAAMM MBG 531.
6. Banding bar shall be 1/4-inch thick minimum. Top of banding bar shall be flush with top of grating, unless otherwise shown or indicated. Banding bar shall be 1/4-inch shorter than the bearing bar height.
7. Comply with requirements of AA Aluminum Design Manual.

B. Stair Treads: Provide stair treads complying with the following:
1. Stair Tread Design Loads: Concentrated live load shall be:
    a. 300 pounds on front-most five inches of tread at center of tread of span up to 5.5 feet.
    b. 300 pounds on front-most five inches of tread at the one-third points of tread of span greater than 5.5 feet.
2. Maximum Clear Span Deflection for Concentrated Live Loads: 1/240 of span, but not more than 1/4-inch.
3. Maximum Fiber Stress: 12,000 psi.
4. Minimum Size of Members:
    a. Minimum size of bearing bars shall be within standard mill tolerance as indicated in load tables in NAAMM MBG 531 for applicable loading and deflection requirements.
    b. Minimum dimensions of cross bars shall be as indicated in tables of Minimum Standard Cross Bars and Connecting Bars in NAAMM MBG 531.
5. Carrier plate shall be 1/4-inch thick minimum. Top of carrier plate shall be flush with top of tread, unless otherwise shown or indicated. Provide carrier plate with hole and slot for attachment to stringer.
6. Comply with requirements of AA Aluminum Design Manual.

2.2 MANUFACTURERS

A. Grating, Products and Manufacturers: Provide one of the following:
1. Swage-Locked Bar Grating, by Ohio Gratings.
2. Swage-Locked Bar Grating, by AMICO.
3. Or equal.

B. Stair Treads, Products and Manufacturers: Provide one of the following:
1. Rectangular Bar Treads, by Ohio Gratings.
2. Rectangular Bar Treads, by AMICO.
3. Or equal.

2.3 MATERIALS

A. Bearing Bars: Aluminum alloy 6061-T6 or alloy 6063-T6, complying with ASTM B221.

B. Cross Bars or Bent Connecting Bars: Aluminum alloy 6063-T1, complying with either ASTM B221 or ASTM B210.

C. Frames: Aluminum alloy 6061-T6 or alloy 6063-T6, complying with ASTM B221.

D. Stud anchors welded to steel supports and other fasteners shall be Type 316 stainless steel.

2.4 FABRICATION

A. Use materials of minimum depth and thickness specified and required to comply with performance criteria in the Contract Documents.

B. Provide grating as follows:
1. Grating Type: Aluminum rectangular bar with swage-locked cross bars at right angles to bearing bars.
2. Depth: One-inch minimum.
3. Bearing Bars: Aluminum rectangular bar spaced at 1-3/16-inch on centers.
4. Cross-Bars: Swage-locked to bearing bars at maximum spacing of four inches on centers.
5. Surface: Serrated.
6. Finish: Mill.

C. Provide stair treads as follows:
1. Tread Type: Aluminum rectangular bar with swage-locked cross bars at right angles to bearing bars.
2. Depth: One-inch minimum.
3. Bearing Bars: Aluminum rectangular bar spaced at 1-3/16-inch on centers.
4. Cross Bars: Swage-locked to bearing bars at maximum spacing of four inches on centers.
5. Surface: Serrated.
6. Nosing: Cast aluminum abrasive nosing.
7. Finish: Mill.

D. Provide cutouts in grating for passage of piping, electrical conduit, valve stems, columns, ducts, and similar work. Where more than two bearings bars are included in a cut out, provide banding bars of same dimensions as bearing bars around opening welded to grating component parts.

E. Gratings shall be accurately fabricated, free from warps, twists, and other defects that would affect grating appearance and grating serviceability.

F. Welding shall conform to requirements of NAAMM MBG 533. Welds shall be ground smooth at top surfaces and bearing surfaces.

G. Openings in and edges of gratings sections shall be banded with banding bars. Weld bands to intersecting members.

H. Size each section of grating to weigh not more than 100 pounds, unless otherwise indicated in the Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions under which Work is to be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Check all dimensions at the Site after piping and equipment are in place and determine exact locations of openings and cutouts.

3.2 INSTALLATION

A. Fastening to In-Place Construction:
   1. Use anchorage devices and fasteners to secure aluminum grating to supporting members or prepared openings, as recommended by manufacturer.
   2. Weld Type 316 stainless steel stud bolts to receive saddle clip or flange block anchors to supporting steel members. Drill for machine bolts when supports are aluminum.

B. Cutting, Fitting, and Placing:
   1. Perform cutting, drilling and fitting required for installation. Set the Work accurately in location, alignment and elevation, plumb, level, true, and free of rack. Do not use wedges or shimming devices.
   2. Where gratings are penetrated by piping, electrical conduit, ducts, structural members, or similar protrusions, cut openings neatly and accurately to size and attach banding bar as specified.
   3. Divide panels into sections only to extent required for installation where aluminum grating is to be installed around previously installed piping, electrical conduit, ducts, structural members, or similar protrusions.

C. Aluminum gratings in concrete floors shall be removable and arranged in sizes to be readily lifted. Provide aluminum gratings in concrete with aluminum angle frames with mitered corners and welded joints. Grind exposed joints smooth. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected for flush fit.

D. Clearance at ends or between sections of grating shall be a maximum of 1/4-inch.

E. Tops of aluminum gratings shall be set flush with surrounding construction.

F. Aluminum gratings shall be set with full and uniform end bearing on frames to preclude rocking movement; do not use wedges or similar shimming devices.

G. Protection of Aluminum from Dissimilar Materials: Coat aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel, or other metals, in accordance with Section 09 9100, Painting.

END OF SECTION 05 5316

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SECTION 05 5534

ACCESS HATCHES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including but not limited to Division 01, General Requirements.

1.2 DESCRIPTION OF WORK

A. The Contractor shall provide all labor, materials, equipment, and incidentals required to furnish and install in good workmanlike manner all hatches as shown on the contract drawings and as specified herein.

1.3 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 SURFACE MOUNTED FLOOR HATCH (TYPE 1)

A. The single leaf access frames and covers shall have a 1/4 inch thick, mill finish, aluminum frame designed for surface mounting. Door panel shall be 1/4 inch aluminum diamond plate, reinforced to withstand a 10 foot column of stationary water, or approximately 625 lbs. Psf. The door shall incorporate a 90 degree return flange around the perimeter.

B. The cover shall have overlap the frame and extend down 2 inches.

C. Stainless steel pressure locks shall be provided to work in conjunction with a 1/4 inch thick neoprene compression gasket, mounted to the underside of the door, to insure minimal water intrusion. Door shall open to 90 degrees and automatically lock with a stainless steel hold open arm with aluminum release handle. Hinges and all fastening hardware shall be 316L stainless steel. Unit shall lock with pad lock lugs. Unit shall be guaranteed against defects in material and/or workmanship for a period of 10 years.
   1. Provide anodized coating to protect all aluminum and stainless steel from Chlorine Gas.
   2. Provide powder-coated aluminum safety grating across opening.
   3. Grease stainless steel hardware to protect against Chlorine Gas.
   4. Manufacturers: Halliday products, Bilco or equal.

D. Provide safety grate below hatch.
   1. Safety Grate shall be designed to combine covering of the hole per OSHA standard 1910.23 and shall include fall-through protection and controlled confined space entry. The safety grate shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi and a minimum yield strength of 35,000 psi, per ASTM B221. Grate design shall use safety factors as defined in the “Specifications for Aluminum Structures”

by the Aluminum Association, Inc., 5th addition, Dec. 1986 for "Bridge Type Structures." Aluminum grating shall be designed to withstand a minimum live load of 300 lbs per sq ft. Deflection shall not exceed 1/150th of the span. Aluminum grate openings shall be (I bar grating with 1-3/16inch x 4inch opening with view area for observation and limited maintenance) 5 inch x 5 inch, which will allow visual inspection of the pit once the access hatch is opened. Each Aluminum grate shall be provided with a permanent hinge system which will lock the grate in the 90 degree position once opened. Design of the system must assure fall through protection is in place after the door has been closed, thereby protecting the next operator. Each grate shall have an opening arm with a red vinyl grip handle, which will allow opening of the grate, while providing the grate as a barrier between the operator and the pit. The opening arm shall also be equipped with a controlled confined space entry locking device (lock provided by others). This locking device will prevent unauthorized entry to the confined space. The grating system will allow anyone to make visual inspection and float adjustments without entering the confined space. Grate shall be painted with OSHA type safety orange paint. Welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum.

2.2 FLUSH MOUNTED ACCESS HATCHES (TYPE 2)

A. Covers with Frames for Drainage
   1. Design Loadings and Sizing: Design for live load capacity of 300 psf.
   2. Thickness of Frames and Doors Leaves: 1/4 inch thick, minimum.
   3. Provide stainless steel hinges, springs, and all other hardware.
   4. Provide stainless steel safety chain across opening.
   5. Product and Manufacturer
      a. Halliday Type KD, Bilco Type J, or Babcock-David Associates Type AM.

B. Components:
   1. Door Leaf Surface: Checkered, diamond plate, or other approved non-slip surface.
   2. Frame Anchors: Aluminum anchor flanges or strap anchors.
   3. Door Opening Mechanism
      a. Hold-Open Device.
      b. Door Leaves Ten Square Feet and Larger: Torsion bar springs or other approved means for counterbalanced operation.
   4. Cover Latch: Flush exterior locking device with removable handle and interior turn handle. Include locking hasp to receive Owner's padlock on exterior.
   5. Aluminum Covers: Mill-finished. Protect finish with a factory-applied coating of lacquer standard with the manufacturer.
   6. Coat surfaces in contact with concrete with bituminous coating: 30 mils dry film Tnemec 46H-413 Hi-Build Coal Tar Epoxy or equal.

C. Aluminum Material
   1. Extruded shapes and tubes: ASTM B221 or B308, 6061-T6.
   2. Extruded pipe: ASTM B429, 6063-T6.
   3. Plate and sheet: ASTM B209, alloy 3003-H16. Use alloy 5005 H16 where anodic coatings will be applied.
   4. Bars, rods and wire: ASTM B211.
   5. Castings: ASTM B26 or B108; alloy 214 for natural anodized finish, and alloy 43 for color anodized or baked enamel finish; except as otherwise recommended by aluminum producer or finisher.

6. Forgings: ASTM B247, alloy 6061-T6.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the hatches and appurtenances shall be done in accordance with written instructions provided by the Manufacturer.

END OF SECTION 05 5534

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SECTION 05 5600

METAL CASTINGS

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install metal castings.
2. Castings include metal items that are not part of miscellaneous metal fabrications or metal systems in other Specifications Sections.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before metal castings Work.

1.2 REFERENCES:

A. Standards referenced in this Section are:
1. ANSI A14.3, Safety Requirements for Fixed Ladders.
2. ASTM A48/A48M, Specification for Gray Iron Castings.
3. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
4. ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections.

1.3 QUALITY ASSURANCE:

A. Qualifications:
1. Manufacturer: Shall have at least five years experience manufacturing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
1. Obtain all frame, lid or cover, grate, and manhole step products included in this Section regardless of component manufacturer, from a single castings manufacturer.
2. Obtain all hydrostatic pressure relief valve products included in this Section regardless of component manufacturer, from a single castings manufacturer.
3. Castings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
4. Components shall be constructed for specified service conditions and shall be integrated into overall assembly by castings manufacturer.

1.4 SUBMITTALS:

A. Action Submittals: Submit the following:
1. Shop Drawings:

a. Fabrication and installation of all casting assemblies. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.

2. Product Data:
   a. Copies of manufacturer's catalog information for the products proposed for use, specifications, load tables, dimension diagrams, anchor details, and installation instructions.

B. Informational Submittals: Submit the following:
1. Certificates:
   a. Furnish certification, signed by authorized officer of Contractor and notarized, stating that all components are furnished by the same manufacturer.
   b. Manufacturer's certification that the casting or lot of castings was made, sampled, tested and inspected in accordance with ASTM A48.
2. Qualifications Statements: Submit qualifications for the following:
   a. Manufacturer, when required by Engineer.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Packing, Shipping, Handling, and Unloading:
1. Deliver products to the Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
2. Comply with Section 01 6000, Product Requirements.

B. Storage and Protection:
1. Protect materials from corrosion and deterioration.
2. Comply with Section 01 6000, Product Requirements.

PART 2 – PRODUCTS

2.1 MATERIALS:

A. Round Manhole Frame with Solid Lid:
1. Material: ASTM A48/A48M, Class 35 B.
2. Lids for sanitary manholes shall be lettered "Sanitary" or "Sanitary Sewer". Lids for storm manholes shall be lettered "Storm" or "Storm Sewer".
3. Products and Manufacturers: Provide one of the following:
   a. R-1776, manufactured by Neenah Foundry Company.
   b. 1251 with type A cover, manufactured by East Jordan Iron Works, Inc.
   c. Or equal.

B. Catch Basin Type (2-2A and 2-2B) Grate:
1. Material: ASTM A48/A48M, Class 35 B.
2. Products and Manufacturers: Provide one of the following:
   a. R-4859-S, manufactured by Neenah Foundry Company.
   b. 5110 with Type M3 Grate, manufactured by East Jordan Iron Works, Inc.
   c. Or equal.

C. Curb Inlet Frame Grate and Curb Box:

1. Material: ASTM A48/A48M, Class 35 B.
2. Products and Manufacturers: Provide one of the following:
    a. R-3067-V, manufactured by Neenah Foundry Company.
    b. V-4066-1, manufactured by East Jordan Iron Works, Inc.
    c. Or equal.

D. Standard Clean Out Frame and Lid:
1. Material: ASTM A48/A48M, Class 35 B.
2. Products and Manufacturers: Provide one of the following:
    a. R-1910-D, manufactured by Neenah Foundry Company.
    b. V-1610-3 with Type A cover, manufactured by East Jordan Iron Works, Inc.
    c. Or equal.

E. NFC Clean Out Frame and Lid:
1. Material: ASTM A48/A48M, Class 35 B.
2. Products and Manufacturers: Provide one of the following:
    a. R-1530, manufactured by Neenah Foundry Company.
    b. 1058 with solid cover, manufactured by East Jordan Iron Works, Inc.
    c. Or equal.

2.2 FABRICATION:

A. Fabrication, General:
1. Castings shall be of uniform quality, free of sand holes, gas holes, shrinkage cracks, and other surface defects.
2. Castings shall be ground smooth and well-cleaned by shot blasting in the shop.
3. Design and fabricate round frames and covers to prevent rocking and rattling under traffic loads that will be imposed in actual use.
4. Fabricate castings true to pattern so that component parts fit together.
5. Each casting shall be identifiable and, depending on its size, shall indicate the following: name of producing foundry, ASTM material designation, individual part number, and cast or heat date. Castings shall include all lettering shown or indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSPECCTION:

A. Examine conditions under which Work is to be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION:

A. Comply with casting manufacturer's printed instructions and the Contract Documents. Where castings are installed on precast concrete, fabricated fiberglass, or other fabricated products, install casting in accordance with requirements of manufacturer of product on which casting will be installed.

B. Set castings accurately to required location, alignment, and elevation, plumb, level, true and free of rack, measured from established lines and levels. Where applicable, brace temporarily or anchor temporarily in formwork.

END OF SECTION 56 5600

SECTION 06 1053

MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, material, tools, equipment, and incidentals as shown, specified, and required to furnish and install all miscellaneous rough carpentry Work.
   2. The Work also includes:
      a. Providing openings in miscellaneous rough carpentry to accommodate the Work under this and other Sections and building into miscellaneous rough carpentry items such as sleeves, anchorages, inserts and other items to be embedded in or penetrating miscellaneous rough carpentry for which placement is not specifically provided under other Sections.
   3. Extent of miscellaneous rough carpentry is shown or indicated.
   4. Types of materials required include:
      a. Miscellaneous blocking, furring strips, and other miscellaneous wood framing.
      b. Lumber for temporary protection.
      c. Lumber for temporary support.
      d. Pressure treatment of lumber specified in this Section.
      e. Miscellaneous accessories.
      f. Air and water infiltration barrier system.
      g. Vapor barrier system.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before miscellaneous rough carpentry Work.

C. Related Sections:
   1. Section 05 0533, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ALSC PS 20, American Softwood Lumber Standard.
   2. ASME B18.2.1 Square and Hex Bolts and Screws, Inch Series.
   3. ASME B18.6.1 Wood Screws, Inch Series.
   4. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   5. ASTM D6841, Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber.
   6. ASTM F1667, Specification for Driven Fasteners: Nails, Spikes, and Staples.
   7. APA E445S, Performance Standards and Policies for Structural-Use Panels (APA PRP-108).
   8. NIST PS-1, Construction and Industrial Plywood.
   9. National Lumber Grade Authority (NLGA), Standard Grading Rules for Canadian Lumber.

10. Northeastern Lumber Manufacturers Association (NELMA), Standard Grading Rules for Northeastern Lumber.
11. Southern Pine Inspection Bureau (SPIB), Standard Grading Rules for Southern Pine Lumber.
12. West Coast Lumber Inspection Bureau (WCLIB), Standard Grading Rules.
13. Western Wood Products Association (WWPA), Western Lumber Grading Rules.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of authorities having jurisdiction and the building code referred to in Section 01 4100, Regulatory Requirements for size, spacing and attachment of wood members, unless more stringent requirements are shown or specified in the Contract Documents.

B. Certifications:
1. Pressure Treatment: For each type of pressure treatment specified, submit certification by wood treating plant stating chemicals and process used, and certifying conformance with applicable standards referenced in the Contract Documents.
    a. For water borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to the Site.
2. Certificates of Grade: Where appearance of wood is important and grade marks will deface the Work, in lieu of grade markings on wood, submit certificates attesting that materials comply with grade requirements specified.

1.4 SUBMITTALS

A. Action Submittals; Submit the following:
1. Shop Drawings:
    a. List of species and grade of lumber proposed for each use.
    b. Fastener schedule with location, size, material and type of each fastener to be used in the Work.

B. Informational Submittals: Submit the following:
1. Certificates:
    a. Lumber treater’s certification of compliance, in accordance with Paragraph 1.3.B.1 of this Section.
    b. Certificates of grade in accordance with Paragraph 1.3.B.2 of this Section.
2. Tests and Evaluation Reports:
    a. For fire retardant treated structural panels, test data and design adjustment values in accordance with ASTM D5516 and ASTM D6305.
    b. For fire retardant treated lumber, test data and design adjustment in accordance with ASTM D5664 and ASTM D6841.
3. Manufacturer’s Instructions:
    a. Chemical treatment manufacturer’s instructions for proper use of each type of treated material.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:

1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete or masonry in ample time to prevent delaying the Work.
2. Handle treated materials in accordance with AWPA M4.
3. Comply with Section 01 6500, Product Delivery Requirements.

B. Storage and Protection:
1. Keep materials dry during delivery and storage.
2. Keep materials off ground using pallets, platforms, or other appropriate supports. Protect materials from corrosion and deterioration. Stack lumber, and provide air circulation within stacks.
3. Comply with Section 01 6600, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber, General:
1. Factory-mark each piece of lumber with type, grade, mill and grading agency. Surfaces that will be exposed to view shall not have grade marks or other types of identifying marks.
2. Nominal sizes are shown or indicated, unless otherwise shown or indicated in the Contract Documents. Provide actual sizes as required by ALSC PS 20 for moisture content specified for each use.
   a. Provide dressed lumber, surfaced four sides (S4S), unless otherwise shown or specified.
   b. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing.
3. Provide the following grade and species:
   a. Construction Grade, for material up to and including four-inch wide.
   b. No. 2 or better for material greater than four-inch wide up to and including 12-inch wide.
   c. Eastern White Pine, NELMA.
   d. Spruce-Pine-Fir, NLGA.
   e. Hem-Fir (North), NLGA.
   f. Southern Pine, SPIB.
   g. Douglas Fir, WCLB.
   h. Douglas Fir, WWPA.
4. Lumber for Protection and Temporary Support: Size and grades to conform to Laws and Regulations, including OSHA.

B. Vapor Barrier:
1. Provide reinforced rubber, modified high density polyethylene vapor barrier with perm rating of 0.045 maximum. Provide maximum widths to minimize field seaming.
2. Provide adhesive, tapes and flashings as recommended by vapor barrier manufacturer, of type that maintains perm rating of entire vapor barrier installation
3. Products and Manufacturers: Provide one of the following:
   a. Rufco SS-300 Vapor Retarder and Adhesives by Raven Industries, Inc.
   b. Or equal.

C. Fasteners and Anchorages:

1. Fasteners exposed to the weather as well as fasteners embedded in, or in contact with, preservative treated wood shall be hot-dip galvanized.
2. Common wire nails shall conform to ASTM F1667.
3. Wood screws shall conform to ASME B18.6.1.
4. Lag screws and lag bolts shall conform to ASME B18.2.1.
5. Anchorage devices shall conform to Section 05 0533, Anchor Systems.
6. Use joist hangers, framing anchors and clips where shown or specified.
    a. Joist hangers shall be steel, zinc coated, sized to fit the supporting member, of sufficient strength to develop full strength of the supported member in accordance with applicable building code, and furnished complete with special nails required by joist hanger manufacturer.
    b. Framing anchors shall be hot-dip galvanized steel conforming to ASTM A653/A653M, Z275 G90. Steel shall not be lighter than 18-gage. Use special nails furnished by manufacturer for nailing.
    c. Clips shall consist of hot-dip galvanized conforming to ASTM A653/A653M, Z275 G90 steel angles, minimum 3/16-inch thick.

D. Wood Trim:
1. Western red cedar, custom grade.
2. Provide solid wood boards and battens complying with ALSC PS 20 and with applicable grading rules of authorized lumber inspection bureau or association under which each species is produced, S4S, with square edges.
3. Provide dressed, seasoned boards and battens with 15 percent maximum moisture content complying with dry size requirements of ALSC PS 20. Mark boards “MC-15” (moisture content 15 percent) or “KD” (kiln dried).

E. Panel edge clips: Extruded galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrates and supporting structure and conditions under which miscellaneous rough carpentry Work will be installed and notify Engineer in writing of conditions detrimental to proper completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Coordination: Fit miscellaneous rough carpentry Work to other Work and work under other contracts, as applicable, and scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other construction.

B. General:
1. Discard units of material with defects that might impair quality of the Work, and units too small to fabricate the Work with minimum joints or optimum joint arrangement.
2. Set miscellaneous rough carpentry Work accurately to required levels and lines, with members plumb and true, accurately cut and fitted.

3. Securely attach miscellaneous rough carpentry Work to substrates by anchoring and fastening as shown and indicated in the Contract Documents. Countersink nail heads on exposed miscellaneous rough carpentry Work and fill holes. Make tight connections between members.
4. Install fasteners without splitting of wood, pre-drill as required and for masonry anchors fastened to wood stud wall framing.

C. Wood Grounds, Nailers, and Blocking:
1. Provide where shown or indicated, and where required for attachment of other construction. Form to shapes as shown or indicated and cut as required for true line and level of Work to be attached. Coordinate location with other work involved.
2. Attach substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown or indicated.
3. Provide permanent grounds of dressed, preservative-treated, key-bevelled lumber not less than 1.5-inch wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

D. Plywood, General:
1. Install in accordance with the Contract Documents and requirements of authorities having jurisdiction.
2. Allow for installed clearances between individual plywood panels as specified by plywood manufacturer. Provide 1/4-inch space at panel edge joints and 1/8-inch space at panel end joints, unless otherwise recommended by manufacturer.
3. Install plywood with long dimension across supports.
4. Install roof sheathing using 8d helical or annular nails spaced fix inches at panel edges and 12 inches at intermediate framing.
5. Provide panel edge clips at unsupported edges of roof sheathing.

E. Vapor Barrier:
1. Install vapor barrier over entire interior room-side surfaces of exterior gypsum board perimeter walls, and over entire interior room-side surface plane of bottom of ceiling joists.
2. Install in accordance with manufacturer's written recommendations and using all taped joints and all taped fastener location to maintain perm rating of entire installed system in accordance with the Contract Documents.

END OF SECTION 06 1053

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SECTION 06 8213

FIBERGLASS-REINFORCED PLASTIC GRATING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install fiberglass-reinforced plastic (FRP) grating. The Work also includes:
      a. Providing openings in FRP grating to accommodate the Work under this and other Sections and attaching to FRP grating all items such as sleeves, bands, studs, fasteners, and items required for which provision is not specifically included under other Sections.
      b. Providing openings in and attachments to FRP grating to accommodate work under other contracts, and assisting other contractors in building on or attaching to FRP grating items such as bands, fasteners, and studs and items required for which provision is not specifically included under other contracts.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before FRP grating Work.

C. Related Sections:
   1. Section 05 0533 Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO, Standard Specifications for Highway Bridges.
   2. ASTM D635, Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   3. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Manufacturer shall have a minimum of five years experience producing materials substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all products furnished under this Section regardless of component manufacturer from a single FRP grating manufacturer.
   2. FRP grating manufacturer shall prepare, or shall review and approve, all Shop Drawings and other submittals for components furnished under this Section.

C. Regulatory Requirements: Comply with the following:

1. OSHA, 29 CFR 1910.23, Guarding Floor and Wall Openings and Holes.
2. Building codes referred to in Section 01 4100, Regulatory Requirements.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and erection drawings and schedules of all materials included under this Section. Include plans, elevations, and details, including connection details. Show anchorage and accessory items. Shop Drawings shall indicate location of planned field cut-outs in grating.
      b. Obtain Engineer's approval of field cut-outs in grating.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, and anchorage details.

B. Informational Submittals; Submit the following:
   1. Manufacturer Instructions:
      a. Setting drawings and templates for location and installation of anchorage devices.
      b. Manufacturer instructions for handling, storing, and installing the materials furnished.
   2. Qualifications Statements:
      a. Manufacturer qualifications, when requested by Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
   1. Protect materials from corrosion, staining, scratching, and deterioration.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. Maximum clear span deflection under uniform load equal to 250 pounds per square foot shall be the smaller of 1/200 of span or 1/4-inch, at four feet.
   2. Flame Spread Rating: 25 or less, ASTM E84; self-extinguishing ASTM D635.
   3. Sheet Size: As shown or indicated in the Contract Documents, and as required to comply with deflection requirements.
   4. Design Loads:
      a. Uniform live load shall be as shown. Where the live load is not shown, the uniform live load shall be as indicated below or the indicated concentrated load, whichever gives the greatest stresses.

	Live Load (psf)	**Concentrated Load (lbs per foot of grating at center of span)**
1)	100	500
2)	150	750
3)	200	1,000
4)	300	1,500

b. Maximum Clear Span Deflection for Uniform Live Loads: 1/240 of span, but not more than 1/4-inch.
c. Maximum Clear Span Deflection for Concentrated Loads: 1/180 of span.

B. High Load Capacity Molded FRP Grating: Provide materials complying with the following:
1. Grating shall be pultruded construction and designed for a maximum 1500 pounds wheel load and a non-concurrent 400 psf live load.
2. Pattern: Mesh configuration H147, 1-3/16" load bar spacing; 3" tie bar spacing on center.
3. Thickness: Three inches

C. Pultruded FRP Grating: Provide products conforming to the following:
1. Grating shall be pultruded construction with I-bar configuration of bearing bars and tie bars providing single-directional strength.
2. Depth: 1.5-inch minimum
3. Bearing Bars: Fiberglass I-bar minimum of one-inch spaced at 1.2-inch on centers.
4. Cross-Bars: Swage-locked to bearing bars at maximum spacing of four inches on centers.

D. FRP Stair Treads: Provide pultruded stair treads complying with the following:
1. Stair Tread Design Loads: Concentrated live load shall be:
a. 300 pounds on front-most five inches of tread at center of tread of span up to 5.5 feet.
b. 300 pounds on front-most five inches of tread at the one-third points of tread of span greater than 5.5 feet.
2. Maximum Clear Span Deflection for Concentrated Live Loads: 1/240 of span, but not more than 1/4-inch.
3. Maximum Fiber Stress: 12,000 psi.

2.2 MANUFACTURERS

A. High Load Capacity Molded FRP Grating:
1. Products and Manufacturers: Provide one of the following:
a. Fibergrate High Load Capacity Molded Grating, by Fibergrate Composite Structures, Inc.
b. Or equal

B. Pultruded FRP Grating:
1. Products and Manufacturers: Provide one of the following:
a. Safe-T-Span Pultruded Grating, by Fibergrate Composite Structures, Inc.
b. Duradek Pultruded Fiberglass Grating, by Strongwell Corporation.
c. Or equal.

C. Stair Treads: Provide one of the following:
1. Products and Manufacturers: Provide one of the following:
a. Safe-T-Span Pultruded Treads, by Fibergrate Composite Structures, Inc.
b. Duradek Pultruded Treads, by Strongwell Corporation.
c. Or equal.

2.3 MATERIALS

A. Fiberglass-Reinforced Plastic (FRP):
1. Premium-grade, fire-retardant vinyl ester resin with glass reinforcing.

2. Finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes, or un-reinforced areas. Glass fibers shall be well-covered with resin to protect against exposure due to wear and weathering.

B. Attachment, Clips, Fasteners, and Hardware: Provide titanium clips, bolts, nuts, washers, sleeves, fasteners, and associated hardware.

C. Color and Finish of Grating:
1. Color: Dark gray.

2.4 FABRICATION

A. General:
1. Use materials in accordance with the Contract Documents and approved Shop Drawings and submittals.
2. Sealing: Coat shop-fabricated cuts in FRP with vinyl ester resin.

B. Grating:
1. Reinforce grating with continuous rovings of equal number of layers in each direction. Top layer of reinforcing shall be no more than 1/8-inch below top surface of grating to provide maximum stiffness and prevent resin chipping of un-reinforced surfaces. Percentage of glass (by weight) shall not exceed 35 percent.
2. After molding, dry glass fibers shall not be visible on surface of bearing bars or cross bars. Bars shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin over-rich, or resin-starved areas.
3. Non-slip Surfacing: Grating shall have integrally-applied grit top on the surface of each bar providing maximum slip resistance.
4. Grating bar intersections shall be filleted to minimum radius of 1/16-inch to eliminate local stress concentrations and reduce the potential for resin cracking.
5. Layout: Each grating section shall be readily removable, except where shown or indicated on the Drawings. Manufacturer shall provide openings and holes where shown or indicated on the Drawings. Grating openings around protrusions such as structural elements, piping, conduit, shafts or other machinery, shall be discontinuous at the approximate centerline of the associated opening so each section of grating is readily removable.
6. Provide FRP grating to be installed in concrete with FRP angle frames having mitered corners and welded joints. Frames shall have welded anchors set into concrete. Angle size shall match grating depth selected for flush fit of grating.
7. Where grating is cut, seal the cut surfaces with catalyzed resin sealant of equal or superior corrosion resistance to the grating. Sealant shall be as recommended by grating manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Grating Installation:
   1. After structural elements, piping, conduit, shafts and other equipment are in place check all dimensions in the field and determine required grating cutouts.
   2. Placing:
      a. Install FRP grating with each section readily removable and replaceable, unless shown or indicated otherwise in the Contract Documents. Provide end-banding bars for each grating panel.
      b. Set tops of FRP gratings flush with surrounding construction.
      c. Install FRP grating with full and uniform end bearing on frames or bearing surfaces to preclude rocking movement. Do not use wedges or similar shimming devices.
      d. Provide FRP grating in concrete with angle frames. Grind exposed joints of angle frames smooth.
   3. Cutting and Fitting:
      a. Perform cutting, drilling, and fitting required for installation. Set the grating Work accurately in location, alignment, and elevation, plumb, level, true, and free of rack. Do not use wedges or shimming devices.
      b. Provide cutouts or openings in the field as approved by Engineer.
      c. Seal cut surfaces of grating requiring cutting during installation with sealant.
   4. Connections to Structural Elements and Bearing Surfaces:
      a. Attach gratings to bearing surface in accordance with grating manufacturer's recommendations
      b. Secure grating to FRP structural members, as required by manufacturers of grating and FRP structural member.
   5. Joints:
      a. Fit exposed connections accurately together to form tight joints.
      b. Adjacent units of FRP grating sections shall be neatly fitted together.
      c. Clearance at the ends or between sections of FRP grating shall be a maximum of 1/4-inch.
   6. Jointing Connections:
      a. Secure edges of grating to each other with end-panel clips.
      b. Secure clips to grating with bolts so that grating acts as a unit. Install bolts not more than three inches from each plate section end and not more than two feet on centers.
      c. For each FRP grating panel, provide four saddle clip anchors designed to fit over two adjacent grating section, and four stud bolts with washers and nuts for each grating panel.

END OF SECTION 06 8213

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SECTION 06 8223

FIBERGLASS-REINFORCED PLASTIC
HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, incidentals, and professional design services as shown, specified, and required to furnish and install fiberglass-reinforced plastic (FRP) handrails and railings. The Work also includes:
      a. Providing openings in, and attachments to, FRP handrail and railing systems to accommodate the Work under this and other Sections. Provide all items for FRP handrails and railings, including anchorages, fasteners, studs, and other items required for which provision for is not specifically included under other Sections.
   2. FRP handrails and railings Work shall include components and features shown and specified, and all components and features available from specified manufacturers required for providing complete FRP handrail and railing system in accordance with the Contract Documents.
   3. Handrail and railing systems are shown to indicate general types of locations where handrails and railings are required. Where handrail or railing systems are not shown but may reasonably be inferred from the Contract Documents as required by either an authority having jurisdiction, OSHA, or other Laws or Regulations, provide handrail and railing systems of the type specified in this Section at no additional cost to Owner.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before FRP handrails and railings Work.
   2. FRP handrail and railings shall comply with Laws and Regulations. When Contractor is aware that FRP handrails and railings Work shown or indicated in the Contract Documents does not comply with Laws or Regulations, obtain written interpretation from Engineer.

C. Related Sections:
   1. Section 03 6000, Grouting.
   2. Section 05 0533, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/ASSE A1264.1, Safety Requirements for Workplace/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrails Systems.
   2. ASTM D635, Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   3. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
    a. Manufacturer shall have a minimum of five years experience producing materials substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.
    b. Manufacturer shall be capable of preparing and submitting custom detail shop drawings for the materials required.
2. Professional Engineer:
    a. Contractor or handrail and railing manufacturer shall retain a registered professional engineer legally qualified to practice in jurisdiction where the Site is located. Professional engineer shall have at least five years experience designing FRP handrails and railings.
    b. Responsibilities include:
        1) Reviewing FRP handrail and railing system performance and design criteria stated in the Contract Documents.
        2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
        3) Preparing or supervising preparation of design calculations verifying compliance of FRP handrail and railing system with requirements of the Contract Documents.
        4) Signing and sealing all calculations.
        5) Certifying that:
            a) Design of FRP handrail and railing system was performed in accordance with performance and design criteria stated in the Contract Documents, and
            b) Design conforms to Laws and Regulations, and to prevailing standards of practice.
3. Installer:
    a. Retain a single installer trained and with record of successful experience installing FRP handrail and railing systems.
    b. Installer shall have record of successfully installing FRP handrail and railing systems in accordance with recommendations and requirements of manufacturer, or shall submit evidence of being acceptable to the manufacturer.
    c. Installer shall employ only tradesmen with specific skill and successful experience in the type of Work required.
    d. When requested by Engineer, submit name and qualifications of installer with the following information for at least three successful, completed projects:
        1) Names and telephone numbers of owner and architect or engineer responsible for each project.
        2) Approximate contract cost of the FRP handrail and railing systems for which installer was responsible.
        3) Amount (linear feet) of FRP handrail and railing installed.

B. Component Supply and Compatibility:
1. Obtain all products furnished under this Section regardless of component manufacturer, from a single FRP handrail and railing system manufacturer.
2. FRP handrail and railing system manufacturer shall prepare, or shall review and approve, all Shop Drawings and other submittals (except for delegated design submittals, when professional engineer is retained by other than handrail and railing manufacturer) for all components furnished under this Section.
3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by FRP handrails and railings manufacturer.

C. Regulatory Requirements: Comply with the following:
   1. OSHA, 29 CFR 1910.23, Guarding Floor and Wall Openings and Holes.
   2. Building codes referred to in Section 01 4100, Regulatory Requirements.

D. Certifications:
   1. Furnish notarized certification, signed by authorized officer of manufacturer, stating that handrail and railing systems conform to the design prepared by the professional engineer.
   2. Furnish notarized certification, signed by authorized officer of CONTRATOR, stating that all components and fittings are furnished by the same manufacturer

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit drawings for fabricating and installing FRP handrail and railing systems with sizes of members, tube wall thickness, information on components, and anchorage devices. Show all anchorages. Include details drawn at scale of 1.5-inch equal to one foot.
      b. Indicate required location of posts.
      c. Indicate locations and details of all expansion joints, if any.
      d. Indicate locations and details of gaps across seismic joints, if any.
      e. Profile drawings of FRP handrail and railing system components.
      f. Custom detail drawings. Details of forming, jointing, sections, connections, internal supports, trim, and accessories. Include details drawn at scale of 1.5-inch equal to one foot.
   2. Product Data:
      a. Manufacturer's published literature, specifications, standard detail drawings for FRP handrail and railing systems.
      b. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by Engineer.
   3. Delegated Design Submittals:
      a. Design computations or complete structural analysis of handrail and railing systems, signed and sealed by professional engineer. Professional engineer's seal shall be clearly legible, including jurisdiction of registration, registration number, and name on seal.
      b. Certification by professional engineer that professional engineer has performed design of FRP handrail and railing systems in accordance with performance and design criteria stated in the Contract Documents, and that design complies to Laws and Regulations, and to prevailing standards of practice.
   4. Test Procedure:
      a. Submit detailed description of proposed shop testing procedures. Do not perform shop testing until Engineer approves shop test procedure.
      b. Submit detailed description of proposed field testing procedures. Do not perform field testing until Engineer approves test procedure.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Manufacturer certification that materials were fabricated in accordance with professional engineer's design, in accordance with Paragraph 1.3 D.1 of this Section.
      b. Certification on source of supply, in accordance with Paragraph 1.3 B and Paragraph 1.3.D.2 of this Section.

2. Supplier Instructions:
    a. Instructions for handling, storing, and installing materials furnished.
    b. Templates for mounting to concrete.
3. Source Quality Control Submittals:
    a. Manufacturer's load testing report for FRP handrail and railing systems to be furnished for the Project, demonstrating compliance with requirements of the Contract Documents and Laws and Regulations.
4. Field Quality Control Submittals:
    a. Load testing report for completed, installed FRP handrail and railing systems at the Site, demonstrating compliance with requirements of the Contract Documents and Laws and Regulations.
5. Qualifications Statements: Submit qualifications for the following:
    a. Manufacturer, when requested by Engineer.
    b. Professional engineer, when requested by Engineer.
    c. Installer, when requested by Engineer. Qualifications statement shall include record of experience with references specified.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data: Submit maintenance manuals for materials furnished under this Section, including:
    a. Comply with Section 01 7823, Operations and Maintenance Data.
    b. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods, and precautions in using the materials that may be detrimental to finish when improperly applied.
    c. Handrail and railings systems manufacturer's current catalog including individual parts.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
1. Protect materials from corrosion, staining, scratching, and deterioration.
2. Protect handrails and railings by paper or coating as acceptable to handrail and railing manufacturer, against scratching, splashes of mortar, paint, and other marring during transportation, handling, and erection. Protect until completion of adjacent work.

B. Handling of Products:
1. Do not subject handrail and railing materials to bending or stress.
2. Do not damage edges or handle materials in a manner that will cause scratches, warping, or dents.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:
1. Railing system shall consist of top and one intermediate horizontal rail(s) equally spaced, with toeboards where applicable.
2. Rails, Posts, and Toeboards:
    a. Rails shall each be minimum 1.75-inch square tube, with minimum 1/8-inch wall thickness.

b. Posts shall be minimum of two-inch square tube, 5/32-inch wall thickness with solid reinforcing stiffener.
c. Rails shall be continuous at post intersections.
d. Toeboards shall be 1/2-inch deep by four inches high. Toeboard shall have reinforcing ribs or other manufacturer-standard fabricated toeboard approved by Engineer.

3. Nominal Handrail Height Above Floor: In accordance with Laws and Regulations, but not less than 3.5 feet.
4. Comply with ANSI/ASSE A1264.1.

B. Design Criteria:
1. FRP handrail and railing system shall consist of equally-spaced horizontal rails, mechanical fasteners, and adhesively bonded components, fastened to posts spaced not more than five feet on centers and a system of handrails supported from adjacent construction by mounting brackets spaced at not more than five feet on centers.
2. Design Loads: Design, fabricate, and install FRP handrail and railing systems to withstand the most critical effects resulting from the following loads (loads listed below do not act concurrently):
a. Uniform Load: 50 pounds per foot, applied at top in any direction.
b. Concentrated Load: 200 pounds single load, applied at any point along the top in any direction.
c. Components: Intermediate rails shall withstand horizontally-applied normal load of 50 pounds on an area equal to one square foot, including openings and space between rails. Reactions due to this loading are not required to be superimposed to loading specified for main supporting members of handrails and railings.
d. Comply with generally accepted standards used in the FRP industry for determining allowable stresses and safety factors for structural FRP components.
e. Limit deflection in each single span of railing and handrail to 1.5-inch maximum, and to 1.4-inch maximum on railing posts. Applied loads shall not produce permanent deflection in the completed Work when loads are removed.
3. Thermal Control:
a. Provide adequate expansion within fabricated systems that allows for thermal expansion and contraction caused by material temperature change from 140 degrees F to -20 degrees F without warp or bow of system components.
b. Distance between expansion joints shall be based on providing 1/4-inch wide joint at 70 degrees F, that accommodates movement of 150 percent of calculated amount of movement for specified temperature range.
4. Where handrail and railing systems cross expansion joints in the building or structure, provide expansion joints in handrail and railings systems.
5. For posts located at or near end of runs as shown, uniformly space intermediate posts as required to comply with loading and deflection criteria specified, at intervals no greater than maximum post spacing specified. Where posts are shown or indicated for handrails along both sides of walkways and other similar locations, locate posts opposite each other; do not stagger post locations.
6. Provide each railing system post with solid reinforcing stiffener with outside dimension equal to inside dimension of post. Each post shall receive one reinforcing stiffener.

2.2 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:
1. Dynarail, by Fibergrate Composite Structures, Inc.

2. SAFRAIL, by Strongwell Corporation.
3. Or equal.

2.3 MATERIALS

A. Fiberglass-Reinforced Plastic (FRP):
1. Premium-grade, fire-retardant vinyl ester resin with glass reinforcing.
2. Finished surfaces of FRP items shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes, or un-reinforced areas. Glass fibers shall be well-covered with resin to protect against exposure due to wear and weathering.
3. Fire Resistance: 25, ASTM E84, self-extinguishing ASTM D635.

B. Attachment, Clips, Fasteners, Rivets, and Hardware: Provide titanium clips, bolts, nuts, washers, sleeves, fasteners, rivets, and associated hardware.

C. Color and Finish:
1. Color: Safety Yellow.
2. Finish: None .

D. Manufacturing Method:
1. Handrails and railings shall be pultruded FRP components.

2.4 FABRICATION

A. Handrail and Railing – General:
1. Use materials of minimum size and thickness as specified or indicated in the Contract Documents and in accordance with approved Shop Drawings and submittals.
2. Posts and Tubes:
   a. Fabricate connection of handrail to post so that rails are unbroken and continuous through post without using of packs or splices.
   b. Install bottom rail through post at prepared hole made to fit outside dimensions of rail.
   c. Fit top rail into machined, U-shaped pocket formed into top of post such that rail is located at center of post.
   d. For square cross-section members, exposed post corners shall be radiused to eliminate sharp edges.
   e. Join rails to post through combination of bonding and riveting.
   f. Sharp, protruding edges are unacceptable.
3. Support Post Attachments:
   a. Attach post bases according to the approved Shop Drawings, delegated design submittals, and manufacturer's recommendations.
   b. Reinforce post bases to a minimum height of 8.5 inches.
4. Rail Splices: Where required, splice rails using a 10-inch length of FRP tube bonded and riveted into place using epoxy adhesive, and rivets of material specified for fasteners.
5. Sealing: Coat shop-fabricated cuts in FRP with vinyl ester resin.

2.5 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
1. Minimum Handrails and Railings Systems Plumb Criteria:

a. Limit variation of completed handrail and railing system alignment to 1/4-inch in 12.0 feet.
b. Posts shall be plumb to within 1/16-inch in 3.0 feet.
c. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12.0 feet.

2. Provide "pencil-line" thin butt joints.

B. Tests:
1. Load-test handrail and railing systems at the fabrication facility.
2. Submit written report identifying and documenting testing methods used, loads imposed, and how and where loads were applied, and results of such testing on actual complete handrail and railing systems including anchors and fasteners to be used in the Work.
3. Testing setup shall simulate actual conditions of installation to be used in the Work.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Installation – General:
1. Remove protective wrapping from FRP handrails and railings immediately before installing materials.
2. Adjust handrails and railings prior to securing in place, to ensure proper matching at butting joints and correct alignment throughout their length. Plumb posts in each direction.
3. Installation Tolerances:
a. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
1) Spacing: Plus-or-minus 3/8-inch.
2) Alignment: Plus-or-minus 1/4-inch.
3) Plumbness: Plus-or-minus 1/8-inch.
b. Minimum Handrails and Railings Systems Plumb Criteria:
1) Limit variation of completed handrail and railing system alignment to 1/4-inch in 12.0 feet with posts set plumb to within 1/16-inch in 3.0 feet.
2) Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12.0 feet.
c. Provide "pencil-line" thin butt joints.
4. Secure posts and rail ends to buildings or structures as follows:
a. Anchor posts in concrete by means of sockets set and anchored into the concrete floor. Provide closure secured to bottom of sleeve. Before installing posts, remove debris and water from sleeves. Provide reinforcing stiffeners in each post before installing post; do not install posts without reinforcing stiffeners. For non-removable handrail and railing systems sections, after posts have been inserted into sockets, fill the annular space between each post and socket solid with non-shrink grout in accordance with Section 03 6000, Grouting. Crown grout and slope grout to drain away from posts.

b. Anchor posts to stair stringers with stringer or support flanges, angle type or floor type as required by conditions, shop-connected to posts and bolted to supporting members. Flanges shall be as recommended by FRP handrail and railing manufacturer. Provide reinforcing stiffeners in each post before installing post; do not install posts without reinforcing stiffeners.
c. Side-mount posts by fastening posts securely in brackets attached to fascia as shown and in accordance with approved Shop Drawings.
d. Provide removable railing sections where shown or indicated. Provide removable railing system posts with friction-fitted reinforcing stiffeners in each post. Accurately locate sleeves to match post spacing.

5. Use devices and fasteners recommended by FRP handrail and railing systems manufacturer and as shown or indicated on approved Shop Drawings.

B. Cutting, Fitting, and Placing:
1. Perform cutting, drilling and fitting required for installation.
2. Fit exposed connections accurately together to form tight hairline joints. Do not cut or abrade the surfaces of units that have been finished after fabrication, and are intended for field connections.
3. Make permanent field-splice connections using blind rivets and manufacturer's recommended adhesive and five-inch minimum length connector sleeves. Tightly press-fit field splice connectors and install in accordance with the Contract Documents and manufacturer's written instructions. Comply with epoxy manufacturer's recommendations for requirements of installation and conditions of use. Provide two blind rivets per joint on 180-degree centers.
4. Make splices as near as possible to posts, but not more than 12 inches from nearest post.
5. Secure handrails to walls with wall brackets and end fittings as shown. Locate brackets as shown or, if not shown, at not more than five feet on ceneters.
6. Provide flush-type wall return fittings with the same projection as that shown for wall brackets. Drill wall plate portion of bracket to receive one bolt, unless otherwise shown or indicated.
7. Secure wall brackets to building or structure as follows:
   a. For concrete and solid masonry anchorage, use expansion shields and lag anchors, in accordance with Section 05 0533, Anchor Systems.
   b. For hollow masonry anchorage, use toggle bolts having square heads.
8. Fasten toeboards in place with bolt hardware, not more than 1/4-inch clearance above floor level.

C. Fastening to Existing Construction:
1. Provide heavy-duty fascia or floor flange and anchorage devices and fasteners where necessary for securing handrail and railing systems components to existing construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as required, in accordance with Section 05 0533, Anchor Systems.
2. Use devices and fasteners recommended by the handrail and railing systems manufacturer and as shown on approved Shop Drawings.

D. Expansion Joints:
1. Provide slip joint with internal sleeve extending two inches, minimum, beyond joint on each side.
2. Construct expansion joints as for field splices, except fasten internal sleeve securely to one side of rail only.

3. Locate joints within six inches of a post.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. Load-test handrail and railing systems at the Site.
   2. Submit written report identifying and documenting testing methods used, loads imposed, and how and where loads were applied, and results of such testing on actual complete handrail and railing systems including anchors and fasteners used in the Work.

END OF SECTION 06 8223

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SECTION 06 8253

FIBERGLASS-REINFORCED PLASTIC MISCELLANEOUS FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install fiberglass-reinforced plastic (FRP) miscellaneous fabrications. The Work also includes:
      a. Providing FRP miscellaneous fabrications to accommodate the Work under this and other Sections, attaching to FRP miscellaneous fabrications items such as fasteners, and all items required, including embedded angles, for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before FRP miscellaneous fabrications Work.

C. Related Sections:
   1. Section 03 6000, Grouting.
   2. Section 05 0533, Anchor Systems.
   3. Section 05 5013, Miscellaneous Metal Fabrications.
   4. Section 06 8213, Fiberglass-Reinforced Plastic Grating.
   5. Section 06 8223, Fiberglass-Reinforced Plastic Handrails and Railings.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AISC Manual for Steel Construction
   2. ANSI A14.3 Ladders – Fixed – Safety Requirements.
   3. ANSI/ASSE A1264.1, Safety Requirements for Workplace/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrails Systems.
   4. ASTM D635, Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   5. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have a minimum of five years' experience producing materials substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.
      b. Manufacturer shall be capable of preparing and submitting custom detail shop drawings for the materials required.
   2. Professional Engineer:

a. Contractor or fiberglass reinforced plastic miscellaneous fabrications manufacturer shall retain a registered professional engineer legally qualified to practice in the same state as the Site. Professional engineer shall have at least five years' experience in designing similar systems

b. Responsibilities include:

1) Reviewing fiberglass reinforced plastic miscellaneous fabrications system performance and design criteria stated in the Contract Documents.

2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.

3) Preparing or supervising preparation of design calculations and related Shop Drawings.

4) Signing and sealing all design calculations and Shop Drawings.

5) Certifying that:

a) Design of fiberglass reinforced plastic miscellaneous fabrications systems has been performed in accordance with performance and design criteria stated in the Contract Documents, and

b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice

3. Installer:

a. Engage a single installer skilled, trained, and with record of successful experience in installing FRP miscellaneous fabrications systems in accordance with recommendations and requirements of manufacturer (or who can submit written acceptance by manufacturer), and who employs only tradesmen with specific skill and successful experience in the type of Work required.

b. Submit names and qualification to Engineer with the following information for at least three successful projects:

1) Names and telephone numbers of owner, architects, or engineers responsible for projects.

2) Approximate contract cost of FRP miscellaneous fabrications work.

3) Amount of FRP miscellaneous fabrications installed.

B. Component Supply and Compatibility:

1. Obtain all components for each type of system, such as ladders and cages, stairs and platforms, and structural shapes and framing and supports, each from a single FRP miscellaneous fabrications manufacturer.

2. FRP miscellaneous fabrications manufacturer shall prepare, or shall review and approve, all Shop Drawings and other submittals for components furnished under this Section.

3. Components shall be suitable for specified service conditions and shall be integrated into overall assembly by FRP miscellaneous fabrications manufacturer.

C. Regulatory Requirements: Comply with the following:

1. OSHA 29 CFR 1910.28, Duty to have fall protection and falling object protection.

2. OSHA 29 CFR 1910.23, Ladders.

3. Comply with codes referred to in Section 01 4100 Regulatory Requirements.

D. Certification: Submit the following:

1. Verification that materials purchased for the Work comply with material designations specified in the Contract Documents and the approved Shop Drawings.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings for fabricating and erecting FRP miscellaneous fabrications, indicating sizes of members, materials, components, and anchorage devices, based on requirements of the Contract Documents.
      b. Show location of all anchorage items.
      c. Profiles of FRP miscellaneous fabrications, and details of forming, jointing, sections, connection, internal supports, trim, and accessories. Provide details drawn at scale of 1.5-inch equal to one foot.
      d. Custom details required for the Work under this Section.
   2. Product Data:
      a. Manufacturer's published literature, specifications, standard detail drawings for FRP miscellaneous fabrications.
      b. Manufacturer's catalogs showing complete selection of standard and custom components and miscellaneous accessories for selection by Engineer.

B. Delegated Design Submittals:
   1. Design Data: Submit the following:
      a. Design Calculations
         1) Complete calculations for each FRP miscellaneous fabrication, as one package with the Shop Drawings. Structural calculations shall include all specified performance criteria, required load cases and load combinations used in the design and resulting member forces, reactions, and deflections. The magnitude of reactions on foundations or supports from all critical load combinations shall be tabulated separately. All calculations and assumptions shall be presented so that Engineer can easily follow the progress and logic of Contractor's professional engineer. The design analysis shall include the name and office phone number of the designer to answer questions during the shop drawing review
         2) Design calculations shall be signed, sealed, and dated by Contractor's professional engineer. State of professional engineer's registration, registration number, and name on seal shall be clearly legible.

C. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certification on source of supply, in accordance with Article 1.3 of this Section.
   2. Supplier Instructions:
      a. Instructions for handling, storing, and installing materials furnished.
      b. Templates for mounting to concrete or other existing materials.
   3. Qualifications Statements: Submit qualifications for the following:
      a. Manufacturer, when requested by Engineer.
      b. Professional engineer, when requested by Engineer.
      c. Installer, when requested by Engineer. Qualifications statement shall include record of experience with references specified.

D. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data: Submit maintenance manuals for materials furnished under this Section, including:
      a. Comply with Section 01 7823, Operations and Maintenance Data.

b. Detailed procedures for routine maintenance and cleaning, including cleaning materials, application methods, and precautions in using the materials that may be detrimental to finish when improperly applied.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
1. Protect materials from corrosion, staining, scratching, and deterioration.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description – General:
1. FRP miscellaneous fabrications shall be as shown and shall comply with recommended practices of the American Composites Manufacturers Association, except as otherwise specified in this Section.
2. FRP ladders and stairs shall include all components and features shown and specified. Provide system components and features necessary for a complete system complying with the Contract Documents.
3. Provide ultraviolet light inhibitor in the resin to improve materials' resistance to degradation from ultraviolet light.
4. Where appropriate, provide allowance for trimming and fitting at the Site.
5. Where applicable, comply with ANSI/ASSE A1264.1.

B. Design Criteria:
1. Stairs and Platforms:
a. Stair and Platform Design Live Load: 100 psf.
b. Tread Design Loads: Concentrated live load shall be follows:
1) 300 pounds on front five inches of tread at center of tread spans up to 5.5 feet.
2) 300 pound on front 5.5 feet of tread at 1/3-points of tread span greater than 5.5 feet.
3) Maximum Clear Span Deflection for Concentrated Live Loads: 1/240 of span, but no greater than 1/4-inch.
2. Ladders:
a. Minimum design load on fixed ladders shall be a single concentrated load of 300 pounds applied at any point to produce the maximum load effect on the element being considered. The number and position of additional concentrated loads shall be a minimum of 1 unit of 300 pounds for every 10 ft of ladder height, in accordance with ASCE 7.
b. Where rails of fixed ladders extend above a floor or platform, each side rail extension shall be designed to resist a single concentrated live load of 100 pounds in any direction at any height up to the top of the side rail extension, in accordance with ASCE 7.
c. Consider ice loads where applicable, in accordance with ASCE 7.
d. Wind load on all parts of the ladder, where applicable, in accordance with ASCE 7.
e. Anticipated impact loads resulting from the use of ladder fall prevention systems.
3. Fasteners and Supports:
a. Provide the size, length and load carrying capacity required to carry the specified loadings required by design criteria multiplied by a minimum safety factor of four.

b. Where sizes are shown, the sizes shown shall be considered minimum. Increase size to comply with required design criteria loadings and minimum safety factor specified.
c. Anchors and Expansion Anchors: Comply with Section 05 0533, Anchor Systems.

2.2 MATERIALS

A. Fiberglass-Reinforced Plastic (FRP):
1. Provide premium-grade, glass-reinforced, vinyl ester resin.
2. Fire Resistance: 25 or less, ASTM E84; self-extinguishing ASTM D635.
3. Surfaces that will receive foot traffic, including ladder runs and treads, shall have non-skid surface.

B. Manufacturing Method:
1. Pultrusion Method: FRP ladders, FRP stairs, FRP structural shapes, FRP miscellaneous framing and supports.

C. Attachment, Clips, Fasteners, Rivets, and Hardware: Provide titanium clips, bolts, nuts, washers, sleeves, fasteners, rivets, and associated hardware.

2.3 FABRICATION

A. Shop Assembly: Preassemble items in the shop to the greatest extent possible, to minimize field splicing and assembly of components at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinate installation.

B. FRP Stairs:
1. Products and Manufacturers: Provide of one of the following:
a. FRP Stairs by Fibergrate Composite Structures, Inc, of StonCor Group.
b. FRP Stairs by Strongwell Corporation
c. Or equal.
2. Provide FRP stairs complying with Laws and Regulations and OSHA 29 CFR 1910.27.
3. Fabricate stairs so that bolts and other fasteners do not appear on finish surfaces. Make joints true and tight, and make connections between parts light proof tight.
4. Construct stair units in compliance with sizes and arrangements shown. Provide framing, hangers, columns, struts, clips, brackets, bearing plates and other components for supporting stairs and associated platforms.
5. Provide brackets and bearing surfaces as detailed on the Drawings and as required to anchor and contain the stairs on the supporting structure.
6. Fabricate stringers of FRP channels, or plates, or a combination thereof, as shown or as required. Provide closures for exposed ends of stringers.
7. Construct platforms of FRP structural shapes and miscellaneous framing members, as shown or as required. Bolt framing members to stringers and headers.
8. Grating: Comply with Section 06 8213, Fiberglass-Reinforced Plastic Grating.
9. Handrails and Railing: Comply with Section 06 8223, Fiberglass-Reinforced Plastic Handrails and Railings.

C. FRP Ladders:
1. Fabricate ladders for locations shown or indicated with dimensions, spacing, details, and anchorages as shown and specified. Comply with OSHA 29 CFR 1910 and ANSI A14.3, except as otherwise shown or specified.

a. Unless otherwise shown, provide 1.5 inch diameter continuous side rails, spaced at least 1.5 feet apart.
b. The side rails shall be fiberglass reinforced pultruded polyester with OSHA safety yellow pigment.
c. The side rails shall be 2" square tube with a wall thickness of 0.156 inches minimum or greater as required by analysis. The rungs shall be pultruded 1.25" diameter FRP fluted tube.
d. All joints and rungs shall be riveted.
e. Ladders shall be shop assembled.

2. Fall Prevention System:
   a. Provide each ladder with a fall prevention system complying with 29 CFR 1910.
   b. System shall consist of a carrier rail securely and permanently attached to ladder, over which travels a sleeve to which harness belt can be attached.
   c. Rail:
      1) Notched at six-inch intervals and constructed of galvanized steel.
      2) Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.
      3) For all ladders, include provisions to secure safety sleeve to carrier rail at top of vertical ladder so that sleeve will not slide down rail when safety belt is unsnapped.
      4) Ladders Below Hatches: Rail for ladder shall extend from bottom of ladder to top of ladder. Provide telescoping safety post as specified in this Article.
      5) Ladders Not Below Hatches: Rail for ladder shall extend from bottom of ladder to above horizontal landing or roof at top of ladder, Provide removable extension section at top of ladder. Arrange rail to allow climber to land on landing or roof without unsnapping climber's safety harness
   d. Accessories: Provide with each ladder the following, all furnished by fall prevention system Supplier:
      1) One safety sleeve compatible for use with the rail. Sleeve shall be cast bronze with five zinc-plated steel roller bearings. Sleeve shall travel smoothly on straight or curved rail.
      2) One safety harness that attaches to sleeve. Harness shall be of woven, high-strength nylon, with padded straps and forged steel buckles and rings. Harness shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.
      3) One shock-absorbing Y-lanyard no longer than six feet, complying with ANSI Z359.1. Lanyard shall be 5/8-inch diameter nylon rope with double-locking snap hooks at each end.

D. FRP Platforms:
1. The platform shall be fabricated from FRP structural shapes properly sized to support the specified design live load.
2. The stair and platform shall be provided with FRP grating, railing as specified.

E. FRP Structural Shapes:
1. Products and Manufacturers: Provide of one of the following:
   a. Dynaform Structural Shapes, by Fibergrate Composite Structures, Inc.
   b. EXTREN Series 625 Structural Shapes, by Strongwell Corporation
   c. Or equal.
2. Provide FRP miscellaneous structural framing required to complete the Work.
3. Fabricate FRP shapes to the sizes, shapes, and profiles shown, and as required to complete FRP framing Work.

4. Except as otherwise shown, fabricate from structural shapes, plates, and bars using mitered corners, brackets and splice plates and a minimum number of joints for field connection.
5. Cut, drill and tap units to receive hardware and similar items to be anchored to the Work.

F. Miscellaneous Framing and Supports:
1. Provide FRP miscellaneous framing and supports that are not part of structural FRP framework, as required to complete the Work.
2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings. If not shown, fabricate to required dimensions to receive adjacent grating, plates, storage tanks, doors, and other Work that will be located in, retained by, or supported by FRP framing or supports.
3. Except as otherwise shown or indicated, fabricate from FRP shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
4. Cut, drill, and tap FRP miscellaneous framing and supports to receive hardware and similar items to be anchored to the Work.
5. Anchors:
   a. Provide FRP miscellaneous framing and supports with integrally-welded anchors for casting into concrete or masonry. Furnish inserts if FRP miscellaneous framing or supports are to be installed after concrete or masonry is placed.
   b. Except as otherwise shown or indicated, space anchors at maximum intervals of two feet on centers, and mount FRP units with the equivalent of 1.25-inch by 1/4-inch by eight-inch FRP strips, minimum. Provide larger mounting surface when required for the material or equipment being supported by the FRP miscellaneous farming or supports.
6. For grating requirements refer to Section 06 8213, Fiberglass-Reinforced Plastic Grating.
7. For FRP handrails and railings, refer to Section 06 8323, Fiberglass-Reinforced Plastic Handrails and Railings.

G. Grout: Provide non-shrink grout in accordance with Section 03 6000, Grouting.

2.4 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
   a. Spacing: Plus-or-minus 3/8-inch.
   b. Alignment: Plus-or-minus 1/4-inch.
   c. Plumbness: Plus-or-minus 1/8-inch.
2. Provide “pencil-line” thin butt joints.

B. Tests:
1. Perform manufacturer's standard tests and inspections on FRP miscellaneous fabrications.
2. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and at the Site, conducted by qualified inspection agency. Such inspections and tests shall not relieve Contractor of responsibility for providing materials and fabrication procedures in accordance with the Contract Documents.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which FRP miscellaneous fabrications Work is to be performed and notify Engineer in writing of unsatisfactory tolerances that exceed specified limits and other conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION – GENERAL

A. Install FRP miscellaneous fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.

B. Perform cutting, drilling and fitting required for the installation of FRP miscellaneous fabrications. Do not cut FRP members without approval of FRP manufacturer and Engineer. All cut or machined edges, holes and abrasions shall be sealed with a resin compatible with the resin matrix used in the structural shape recommended by FRP manufacturer.

C. Fit exposed connections accurately together to form tight, hairline joints. Field assemble with fasteners, clips, rivets, and other hardware as required.

D. Anchorage Devices:
   1. Provide anchorage devices, including anchor bolts, and other connectors required for securing FRP miscellaneous fabrications to floors, walls, and other in-place Work.
   2. Anchor securely as shown and as required for the intended use, using concealed anchors where possible
   3. Provide templates and other devices necessary for presetting anchorage devices to accurate locations.
   4. Refer to Section 05 0533, Anchor Systems, for anchorage requirements.

E. Setting Bases and Bearing Plates:
   1. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of FRP bearing plates and FRP base plates.
   2. Set loose and attached FRP base plates and FRP bearing plates for structural members or FRP supports on wedges or other adjusting devices.
   3. Tighten anchorage devices after supported members are positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of FRP base or FRP bearing plate prior to packing with grout.
   4. Place grout between bearing surfaces and bases or plates in accordance with Section 03 6000, Grouting. Finish exposed surfaces, protect installed materials, and allow to cure in accordance with grout manufacturer's instructions, and as otherwise required.
   5. Leveling plates and wood wedges are not allowed.

F. Installation Tolerances:
   1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
      a. Spacing: Plus-or-minus 3/8-inch.
      b. Alignment: Plus-or-minus 1/4-inch.

c. Plumbness: Plus-or-minus 1/8-inch.

2. Provide “pencil-line” thin butt joints.

G. Protection: Protect cast-in sleeves from debris and water intrusion by use of temporary covers or removable foam inserts.

3.3 INSTALLATION OF FRP STAIRS, PLATFORMS, AND LADDERS

A. Installation of FRP Stairs, Platforms, and Ladders – General:

1. Erect FRP stair Work to line, elevation, plumb, square, and true with runs registering level with floor and platform levels, in accordance with the approved shop drawings.
2. Erect FRP platforms to line, elevation, plumb, square, level, and true in accordance with the approved shop drawings.
3. Erect FRP ladders to line, elevation, plumb, square, level, and true in accordance with the approved shop drawings.
4. Provide anchorage devices, connectors, and fasteners where necessary for securing stairs and platforms to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts and other connectors as required.
5. Where masonry walls support FRP stair or platform Work, provide temporary supporting struts, designed for the erection of FRP stair and platform components before installing masonry.

3.4 INSTALLATION OF FRP STRUCTURAL SHAPES

A. Field Assembly:

1. Set FRP structural shapes and members accurately to the lines and elevations shown and indicated. Align and adjust the various shapes and members forming part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
2. Level and plumb individual shapes and members of structure within tolerances as specified in AISC Manual for Steel Construction. For shapes or members requiring accurate alignment, provide clip angles, lintels, and other members, with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
3. Splice members only where shown or indicated.

B. Connections:

1. Comply with AISC Manual for Steel Construction, as applicable, for bearing, adequacy of temporary connections, and alignment.
2. Where holds in shapes or members are inadequately sized, address and make sufficiently large using means recommended by manufacturer of FRP shape or member.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections: All elements of completed FRP miscellaneous fabrications shall be visually inspected by Contractor, installer, and Engineer. Correct defective Work, and correct Work not installed to true line, elevation, and grade.

END OF SECTION 06 8253

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SECTION 07 1113

BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install bituminous dampproofing.
   2. Extent of bituminous dampproofing is shown.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before bituminous dampproofing Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM D1187, Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
   2. ASTM D1227, Specification for Emulsified Asphalt Used as Protective Coating for Roofing.
   3. ASTM D4479, Specification for Asphalt Roof Coatings—Asbestos-Free.
   4. ASTM D4586, Specification for Asphalt Roof Cement, Asbestos-Free.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer: Engage a single installer with successful experience installing bituminous dampproofing, and that is acceptable to or licensed by manufacturer of bituminous dampproofing materials, and that employs only workers with specific skill and successful experience in the type of Work required.

B Component Supply and Compatibility:
   2. Provide all bituminous dampproofing of each type required produced by one manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of all Project-specific surfaces where bituminous dampproofing will be applied.
   2. Product Data:
      a. Manufacturer's specifications and technical data for each required dampproofing material. Indicate VOC content of materials proposed.

B. Informational Submittals: Submit the following:
   1. Certificates:

a. Submit bituminous dampproofing manufacturer's certification or other data substantiating that materials proposed for use comply with the Contract Documents, and are recommended by bituminous dampproofing manufacturer for the required applications.
b. Certification indicating that bituminous dampproofing materials delivered in bulk, if any, to the Site comply with the Contract Documents. Include statistical and descriptive data for each product furnished. Submit certificate with each load before using the material in the load.
c. Certification indicating compliance with Laws and Regulations for air quality regarding maximum VOC content for bituminous dampproofing materials.
d. Certification that materials furnished is Asbestos-free as required by ASTM D4479 and ASTM D4586.

2. Supplier's Instructions:
   a. Manufacturer's instructions for handling and storing.
   b. Manufacturer's instructions for application methods and application procedures.
3. Qualifications Statements:
   a. Installer: Submit copy of manufacturer's acceptance of installer and installer's record of experience in work similar to that required under this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver bituminous dampproofing bulk shipments in original, unopened, undamaged containers with manufacturer's certification indicating compliance with the Contract Documents.
2. Do not store damaged or opened containers at the Site. Remove from Site and do not offer such damaged material again.
3. Include with each bulk shipment information on the material's shelf-life, date, quantity delivered, and other information as may be required to establish acceptability of materials delivered to the Site.

B. Storage of Materials:
1. Store emulsions at temperatures above 40 degrees F.

C. Handling of Materials:
1. Do not open containers or mix components until preparatory Work is completed.
2. Do not use solvent-based bituminous dampproofing without adequate ventilation. Prevent build-up of explosive and hazardous fumes.

1.6 PROJECT CONDITIONS

A. Environmental Requirements:
1. Do not install bituminous dampproofing when ambient air temperature is 40 degrees F or less.
2. Do not apply bituminous dampproofing materials to frozen substrates or to substrate in condition not complying with bituminous dampproofing material manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. For interior and concealed-in-wall uses, provide bituminous dampproofing material that is odor-free after drying for 24 hours.

B. Cold-Applied, Cut-Back Asphalt Dampproofing:
   1. Asphalt Compound: Manufacturer's standard asphalt and cut-back solvent-based compound with mineral stabilizers, recommended for concealed in cavity wall interior applications, compounded to penetrate the substrate and build to a moisture-resistant, firm, elastic coating.
   2. Non-Fibrated Dampproofing Material:
      a. Provide non-fibrated type, spray-applied liquid dampproofing compound, complying with ASTM D4479, Type I.
      b. Products and Manufacturers: Provide one of the following:
         1) Spray-Mastic, by W.R. Meadows, Inc.
         2) Or equal.

C. Cold-Applied Asphalt Emulsion Dampproofing:
   1. Asphalt Emulsion: Manufacturer's standard asphalt and water emulsion, recommended by bituminous dampproofing material manufacturer for below-grade exterior applications to either damp (green) or dry substrates, compounded to penetrate the substrate and build to a moisture-resistant, breathing-type of elastic coating.
   2. Heavy-Fibrated, Torwel-Applied Material:
      a. Provide heavy-fibrated type, trowel-applied mastic dampproofing compound complying with ASTM D1187 Type I, or ASTM D1227 Type II, Class I.
      b. Products and Manufacturers: Provide one of the following:
         1) Hydrocide 700 Mastic, by ChemRex, Inc., Sonneborn Building Products Division.
         2) 920 AF Fibered (Trowel Grade) Emulsion Mastic, by Karnak Chemical Corporation.
         3) Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates and conditions under which bituminous dampproofing Work will be applied, and advise Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. General:
   1. Do not proceed with bituminous dampproofing Work until blocking, nailers, piping, conduits, and other projections through the substrate are installed, with substrate properly patched and sealed or flashed to receive the bituminous dampproofing.

B. Surface Preparation:

1. Remove from the substrate dirt, oil, loose materials, and other substances that interfere with penetration, bond, and performance of bituminous dampproofing materials.
2. Dampen with water surfaces that are dry and are to receive application of bituminous dampproofing. Keep such surfaces damp ahead of application.

3.3 INSTALLATION

A. Cold-Applied, Cut-Back Bituminous Dampproofing on Exterior and Interior Surfaces:
   1. Prime the substrate when recommended by bituminous dampproofing manufacturer's instructions, using the type and quantity of primer recommended by bituminous dampproofing manufacturer.
   2. Apply coating of cold-applied, fibrated mastic bituminous dampproofing material by troweling-on to the substrate at uniform rate of one gallon per 12 square feet to provide uniform dry film thickness of not less than 1/16-inch.
   3. Apply coating of cold-applied, semi-fibrated, semi-mastic bituminous dampproofing material by brushing or spraying at the rate of one gallon per 20 square feet, to provide uniform dry film thickness of not less than 1/16-inch.
   4. Cold-Applied, Non-fibrated Liquid Dampproofing:
      a. Apply coating of cold-applied, non-fibrated liquid bituminous dampproofing material by brushing or spraying at the rate of one gallon per 80 square feet to produce uniform dry film thickness of not less than 12 mils.
      b. After first coat has dried for not less than 24 hours, repeat the application. Apply second coat at rate of one gallon per 120 square feet. Apply second coat at right angles to first coat.
   5. Cant Strips, Fillers and Extension of Coatings:
      a. On exterior surfaces, where lower edge of dampproofing terminates at a horizontal projection (including footings under walls), provide two-inch by two-inch bituminous grout cant strip.
      b. Mix sand with required bituminous material to form a plastic grout; form and compact in place. Provide bituminous grout fillers where shown and where required to close openings in the substrate.
      c. Extend coatings a distance of 12 inches onto adjoining walls, but do not extend onto surfaces to remain exposed-to-view.
   6. Fill cracks, crevices, and grooves. Coating shall be continuous and free of breaks and pinholes. Spread dampproofing around joints, grooves, and slots, and into all chases, corners, reveals, and soffits.

B. Cold-Applied Bituminous Dampproofing Emulsions on Exterior and Interior Surfaces:
   1. Apply coating of fibrated mastic, asphalt emulsion bituminous dampproofing material by trowelling-on to substrate at uniform rate of one gallon per 15 square feet to produce uniform dry film thickness of not less than 1/16-inch.
   2. Apply coating of liquid emulsion bituminous dampproofing material by spraying at the rate of one gallon per 20 square feet to produce uniform dry film thickness of not less than 1/16-inch. When necessary, apply in two coats to obtain required thickness, allowing time for complete drying between coating applications.
   3. Cant Strips, Fillers, and Extension of Coatings:
      a. On exterior surfaces, where lower edge of dampproofing terminates at a horizontal projection (including footings under walls), provide two-inch by two-inch bituminous grout cant strip.

b. Mix sand with required bituminous material to form a plastic grout; form and compact grout in place. Provide bituminous grout fillers where shown and wherever required to close openings in the substrate.
c. Extend coatings a distance of 12-inches onto adjoining walls, but do not extend onto surfaces to remain exposed-to-view.

3.4 PROTECTION OF EXECUTED WORK

A. Protect other work from spillage of bituminous dampproofing materials, and prevent such materials from penetrating and clogging drains, conductors, and other utilities.

B. Remedy damage to other construction that is soiled or otherwise damaged during installation of bituminous dampproofing.

END OF SECTION 07 1113

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SECTION 07 1916

SILATE WATER REPELLENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install silate water repellents.
   2. Extent of surface-applied silate water repellents includes all exterior split-face concrete unit masonry.
   3. Types of silate water repellents required include:
      a. Liquid, colorless, non-gloss-producing, VOC-compliant, applied water repellent.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before silate water repellants Work.
   2. Coordinate water repellant provided with sealant. Water repellant and sealant shall be compatible with each other.

C. Related Sections:
   1. Section 04 2200, Concrete Masonry Units.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Water repellant applicator shall be acceptable to or licensed by water repellant manufacturer and shall be regularly-engaged in installing water repellant products and work similar to the Work required under this Section.

B. Component Supply and Compatibility:
   1. Provide all water repellants of each type required produced by one manufacturer.

C. Regulatory Requirements:
   1. VOC emissions from water repellant materials shall not exceed 343 grams per litre.

D. Mock-up:
   1. Prior to installing materials required under this Section, apply silate water repellant to area acceptable to Engineer on mock-up up required under Section 04 2200, Concrete Units Masonry.
   2. Mock-up shall indicate, relative to silate water repellants, proposed range of color change, surface sheen, and workmanship to be expected in the completed Work. Obtain Engineer's approval of visual qualities of mock-up before starting unit masonry construction and silate water repellants Work.
   3. Provide as many mock-up panels as required to obtain Engineer's approval.
   4. Water repellant application that does not comply with standards approved on mock-up panels shall be removed and reapplied to comply with the Contract Documents.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer’s literature and specifications on products proposed for use. Indicate VOC emissions of materials.
      b. Detailed chemical analysis and test results of previously-performed tests of materials required under this Section applied to surfaces identical to, or similar to, those to which silate water repellants will be applied for the Project.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Manufacturer's certification indicating silate water repellent complies with or exceeds requirements of the Contract Documents.
   2. Supplier’s Instructions:
      a. Manufacturer’s instructions for handling, storing, and shelf-life.
      b. Manufacturer's instructions for methods and application procedures.
   3. Qualifications Statements:
      a. Installer: Submit copy of manufacturer’s acceptance of installer and installer’s record of experience in work similar to that required under this Section.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's instructions for handling, storing, and shelf-life.

1.5 SITE CONDITIONS

A. Environmental Conditions for Installation:
   1. Comply with manufacturer’s installation instructions regarding required temperature of surface to which material is applied.
   2. Do not apply water repellant when ambient air temperature is lower than 50 degrees F.
   3. Do apply materials when ice or frost covers the substrate.
   4. Do apply materials when ambient temperature of surface exceeds 100 degrees F.
   5. Do apply materials in rainy conditions or when heavy rain is expected with four hours after application.
   6. Maintain ambient temperature above 20 degrees F during 24 hours after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:
   1. Protectosil Chem-Trete BSM 40 VOC, by Evonik Degussa Corporation.
   2. Prime-A-Pell Plus Series 662, by Tnemec Company, Inc.
   3. Or equal.

B. Products and Manufacturers: Provide one of the following:
   1. Protectosil Chem-Trete BSM 400, by Evonik Degussa Corporation.
   2. Prime-A-Pell Plus Series V662, by Tnemec Company, Inc.
   3. Or equal.

2.2 MATERIALS

A. Chemical Bonding Water Repellants Without Silicone Resin:
   1. Provide silane solution, with or without diffused quartz carbide; colorless, and VOC-compliant.
   2. When dry, water repellant shall be colorless and without gloss.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine under which the Work will be performed. Notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Verify that surfaces to receive water-repellent are clean, and free of efflorescence, stains, oil, grease, and other foreign matter detrimental to application.

C. Verify that required sealants have been installed in areas to receive water repellant.

3.2 PREPARATION

A. Protection of Adjacent Surfaces:
   1. Protect adjacent surfaces that will not receive silate water repellents. When applied or splashed onto surfaces not required to receive water repellents, remove immediately, using method recommended by water repellant manufacturer. Maintain cleaning materials available at the Site for immediate use.

B. Surface Preparation:
   1. Remove loose particles and foreign matter. Remove grease and oil using solvent, effective alkaline cleaner, or detergent as instructed by water repellant manufacturer. Scrub surfaces with water.
   2. Surfaces shall be dry prior to applying water repellant.

3.3 APPLICATION

A. Provide water repellants in accordance with water repellant manufacturer's instructions and recommendations.

B. Apply in two continuous, uniform coats as recommended by water repellant manufacturer. Allow to dry between coats as recommended by water repellant manufacturer.

C. Protect materials in vicinity of application. During windy conditions, do not apply water repellant by spraying. When plants and other flora receive water repellant coating, immediately remove water repellant from plants and flora by washing.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. Spray Test: After water repellent has dried, spray with water the surfaces to which water repellant was applied. After surfaces have adequately dried, inspect for signs of water

adsorption in presents of Engineer, and reapply water repellant to areas that indicate water absorption.

END OF SECTION 07 1916

SECTION 07 2105

BUILDING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install building insulation.
   2. Extent of each type of building insulation is shown and indicated in the Contract Documents.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before building insulation Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C177, Test Methods for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   2. ASTM C203, Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
   3. ASTM C236, Test Methods for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
   4. ASTM C272, Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
   5. ASTM C303, Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
   6. ASTM C518, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   7. ASTM C520, Test Methods for Density of Granular Loose Fill Insulation.
   8. ASTM C531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars and Monolithic Surfacings.
   9. ASTM C549, Specification for Perlite Loose Fill Insulation.
   10. ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
   11. ASTM C578, Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   12. ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
   13. ASTM C665, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   14. ASTM C764, Specification for Mineral Fiber Loose-Fill Thermal Insulation.
   15. ASTM D696, Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C with a Vitreous silica dilatometer.
   16. ASTM D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
   17. ASTM D2126, Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
   18. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.

19. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
20. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
21. UL 1479, Fire Tests of Through-Penetration Firestops.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturers:
      a. Obtain building insulations, requiring hydrochlorofluorocarbon blowing agent from manufacturer(s) that manufacture product required using blowing agent acceptable for use until the year 2020 and complying in all respects with Copenhagen Amendments to the Montreal Protocol.
      b. Manufacturer shall provide complete technical services including preparation and review of Shop Drawings and submittals, installation methods, and proposed detailing for the Work.
   2. Installer: Engage single installer for each type of building insulation. Each installer shall be skilled, trained, and have record of successful experience in applying and installing each product, and possess successful record of performing work in accordance with recommendations and requirements of manufacturer or that can submit written evidence of being acceptable to manufacturer for providing the required Work. Installers shall employ only tradesmen with specific skill and successful experience in each type of Work required. Submit to Engineer name and qualifications of each installer with the following information for at least three successful, completed projects per installer:
      a. Names and telephone numbers of owner and architect or engineer responsible for each project.
      b. Approximate contract cost of the building insulation system installed.
      c. Quantity (area) of building insulation installed.

B. Regulatory Requirements: Comply with code interpretations by authorities having jurisdiction at the Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing extent of the building insulation Work and all details required for the Work, referencing system components provided as Samples.
      b. Complete selection of fire stop manufacturer's recommended systems for each condition and kind of penetration encountered in the Work. Coordinate with equipment manufacturers for required number and kind of penetrations through fire-rated construction. Provide schedule of penetrations and fire stop system to be included for each condition and kind of penetration encountered.
   2. Product Data:
      a. Material specifications and general recommendations from building insulation manufacturer for each type of building insulation product. Include manufacturer's data substantiating that materials comply with Contract Documents.
      b. Test Reports: Copies of reports of tests on materials being furnished or previously-manufactured, identical materials verifying compliance with physical properties and environmental features specified in the Contract Documents. When requested by Engineer, submit qualifications and summary of experience of testing agencies in performing tests similar to those required.

3. Samples:
    a. Twelve-inch by twelve-inch Samples of each required type of building insulation.
    b. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is responsibility of Contractor.

B. Informational Submittals: Submit the following:
1. Manufacturer's Instructions: Manufacturer's installation instructions. Indicate by copy of transmittal form that installer has received copy of manufacturer's installation instructions.
2. Site Quality Control Submittals: Submit results of specified Site quality control tests.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling of Materials:
1. Do not deliver insulation materials to the Site before the time of installation.
2. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.
3. Handle materials carefully to avoid damage and breakage or compressing of boards to less than their specified thickness, or other damage.
4. Handle materials in manner that prevents inclusion of foreign materials.
5. Conform to Section 01 6500, Product Delivery Requirements.

B. Storage of Materials:
1. Store materials in dry, enclosed area, off ground and away from possible contact with water, ice, and snow.
2. Prevent damage to materials during storage, including minimizing the time materials are stored at the Site before being incorporated into the Work. Store only sufficient quantity of building insulation materials at the Site required for continuous advancement of the Work without causing delay.
3. Conform to Section 01 6600, Product Storage and Handling Requirements.

1.6 SITE CONDITIONS

A. Environmental Conditions:
1. Complete the installation and concealment of building insulation materials as rapidly as possible to avoid damage from adjacent construction operations and adverse weather conditions.
2. Install building insulations when weather and temperature conditions comply with building insulations manufacturers' written recommendations.
3. Install building insulations when damaging environmental condition are not forecasted for the time when exposed systems materials components would be exposed to potential damage from the elements.
4. Protect building insulation Work from precipitation, frost, and direct sunlight.
5. Do not apply pressure-sensitive tape when temperature is below 35 degrees F or above 110 degrees F.
6. Record decisions, conditions, and agreements to proceed with the Work when weather conditions may be unfavorable. State reasons for proceeding, along with names of persons involved, and changes or revisions (if any), if required, to allow the Work to proceed.

1.7 . SCHEDULING

A. Proceed with building insulation Work when preceding Work is ready to receive the Work of this Section.

B. Proceed with building insulation and associated Work after curbs, blocking, substrate board, nailer strips, vents, drains and other projections through the substrates have been installed, and when substrate construction and framing of openings is complete.

C. Proceed with and complete the Work when materials, equipment and tradesmen required for the installation of building insulation and backfilling operations are at the Site and ready to follow with the Work in manner that does not leave the Work vulnerable to damage or deterioration.

D. Do not advance installation of building insulation beyond that necessary for proper sequencing of the Work. Do not advance the Work when there is no proper and secure protection from damaging weather and construction activities.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
1. Thermal Conductivity: Thicknesses shown are for thermal conductivity, k-value at 75 degrees F, specified for each material.
2. Provide adjusted thicknesses based on thicknesses shown or specified for building insulations, as required to comply with required thermal resistances for material having different thermal conductivity.

2.2 MATERIALS

A. Foam Plastic Insulations: Provide the following types:
1. General: Rigid, closed-cell, thermally stabilized, extruded, hydrochlorofluro-carbon blown, foam board insulation consisting of 100 percent virgin extruded polystyrene modified resin complying with ASTM C578.
2. Provide blowing agent with lowest available ozone depletion potential, such as HCFC-142b or better. HCFC-141b is not acceptable.
3. Perimeter Foundation Insulations: Provide very high-load-resisting, rigid foam board insulation complying with ASTM C578, Type VI.
   a. Physical Properties: Provide the following:
      1) Thermal Conductivity (k), ASTM C177 and ASTM C518: 0.20 Btu/inch/hour/square foot/degree F.
      2) Compressive Strength (psi at five percent deformation) ASTM D1621: 40 psi minimum.
      3) Flexural Strength, ASTM C203: 60 psi minimum.
      4) Coefficient of Thermal Expansion, ASTM D696: 3.5x10^5 inches/inch/degree F.
      5) Water Absorption, ASTM C272: Less than 0.1 percent by volume maximum.
      6) Water Vapor Permeance, ASTM E96: 0.3 to 0.8 perms/inch maximum.
      7) Flame Spread, ASTM E84: Five.
      8) Smoke Developed, ASTM E84: 165 maximum.
   b. Thickness: 1 layer at two inches thick.
   c. Width: 2.0 feet.
   d. Length: 8.0 feet.
   e. Products and Manufacturers: Provide one of the following:
      1) STYROFOAM 40 HIGH LOAD by the Dow Chemical Company.
      2) Foamular 400 by Owens-Corning Fiberglass Corporation.

3) Or equal.

4. Cavity Wall Rigid Insulation Board: Provide the following:
   a. Rigid, rectangular boards of extruded polystyrene complying with ASTM C578, Type X and IV.
   b. Physical Properties: Provide the following:
      1) Minimum Compressive Strength, (at 10 percent deformation), ASTM D1621: 25 psi.
      2) Flame Spread, ASTM E84: 10 maximum.
      3) Smoke Development, ASTM E84: 165 maximum.
      4) Vapor Transmission, ASTM E96: 1.1 perms/inch.
      5) Thermal Resistance, ASTM C177: 5.0 per inch.
      6) Maximum Water Absorption, ASTM C272: 0.10 percent by volume.
   c. Size: 1 layers of 16 inches by 96 inches by 1-5/8 inches thick.
   d. Products and Manufacturers: Provide one of the following:
      1) CAVITYMATE Plus by the Dow Chemical Company.
      2) Foamular 250 Square Edge by Owens-Corning Fiberglass Corp.
      3) Or equal.

B. Mineral Fiber Insulation: Provide the following types:
   1. General: Provide insulations formed from inorganic mineral fiber extrusions spun at 2,500 degrees F complying with ASTM C665 and ASTM C764.
   2. Loose Mineral Fiber Insulation: Provide non-asbestos rock, slag, or glass processed into fiber and formed into loose resilient wool mass or granular nodules complying with ASTM C764, Type 1 (for blowing) Type 2 (for pouring).
      a. Physical Properties:
         1) Thermal Conductivity (k), ASTM C764: 0.46 Btu/inch/hour/square foot/degree F.
         2) Ignition Loss: Less than one percent (99 percent pure mineral fiber).
         3) Density, ASTM C 64: 1.5 pounds per cubic foot (pcf).
      b. Products and Manufacturers: Provide one of the following:
         1) Industrial Mineral Wool Fiber by Rock Wool Industries, Inc.
         2) FBX Insulating Wool by Fibrex, Inc.
         3) Or equal.
   3. Safing Insulation: Provide unfaced semi-rigid non-asbestos, non-combustible blankets composed of compounds of spun mineral fiber felt, complying with ASTM C665, Type I.
      a. Physical Properties:
         1) Thermal Conductivity (k), ASTM C518: 0.25 Btu/inch/hour/square foot/degree F.
         2) Density, Manufacturer's Certified Test: Four pounds per cubic foot (pcf).
         3) Flame Spread, ASTM E84: 15 maximum.
         4) Smoke Developed, ASTM E84: Five maximum.
         5) Fire Resistance Rating, ASTM E119: Three hours.
      b. Thickness: Four inches.
      c. Width: 2.0 feet.
      d. Products and Manufacturers: Provide one of the following:
         1) Thermafiber Safing Insulation by USG Interiors, Inc.
         2) FBX Safing Insulation by Fibrex, Inc.
         3) Or equal.

C. Fire-Stop Sealants and Other Fire-Stop System Components: Provide the following:

1. Complete selection of fire-stop manufacturer's recommended silicone rubber fire-stop systems. Provide complete systems complying with UL 1479 with two- or three-hour fire rating. Provide equal fire protection as provided by fire-rating of construction penetrated.
2. Provide multiple component systems coordinated to meet actual conditions encountered in the Work and as recommended by fire-stop manufacturer. In addition to providing fire resistance, fire-stop systems shall also be gas and watertight.
3. Products and Manufacturers: Provide one of the following:
   a. 3M Fire Stop Systems by 3M, Inc.
   b. Or equal.

D. Miscellaneous Materials and Accessories: Provide the following:
1. Adhesive for Bonding Insulation: Type recommended by insulation manufacturer, and complying with fire resistance requirements.
2. Mechanical Anchors: Type and size shown or, if not shown, as recommended by insulation manufacturer for type of application shown and condition of substrate.
3. Safing Impaling Clips: Provide galvanized steel impaling clips complying with requirements of code authorities having jurisdiction at the Site and as recommended by insulation manufacturer for full system responsibility.
4. Protection Board: Fiberboard sheathing or heavy duty asphaltic panels as recommended by insulation manufacturer.
5. Adhesive Tapes: Complete selection of insulation manufacturer's recommended taping materials.
6. Bitumen: Asphalt, ASTM D 449.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and installer shall examine substrate and conditions under which building insulation Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surfaces to receive building insulation shall be clean of all debris, dirt, and other contamination before installation begins.

3.3 INSTALLATION

A. General:
1. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to Site conditions, before proceeding with the Work obtain from manufacturer and submit to Engineer specific installation recommendations from manufacturer.
2. Extend insulations full thickness over entire surface to be insulated. Cut and fit tightly around obstructions. Fill voids with insulation.
3. Apply number of layers of insulation specified, each of required thickness, or required thickness to provide thermal value shown or indicated in the Contract Documents, to make up the total thickness.

B. Unit-type Building Insulation:

1. Apply insulation units of type shown or indicated to substrate by method indicated. If not otherwise indicated and except for units resting on horizontal surfaces, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
2. Seal joints between closed-cell (non-breathing) insulation units by applying mastic or sealant of type recommended by the manufacturer to edge of each unit to form tight seal as units are shoved into place. Fill voids in completed installation with mastic or sealant.
3. Set vapor barrier faced units with vapor barrier to warm side of construction, (usually toward inside), except as otherwise shown or indicated. Do not obstruct ventilation spaces, except for fire-stopping.
4. Tape joints and ruptures in vapor barriers using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction so as to ensure vapor-tight installation of the units.
5. Stuff loose mineral fiber insulation into miscellaneous voids and cavity spaces as indicated. Compact to approximately 40 percent of normal maximum volume to density of approximately 2.5 pounds per cubic foot.

C. Safing Insulations and Fire-Stop Systems:
1. Install safing insulation and fire-stop systems to present continuous fire-rated fire barrier in areas shown and at perimeter of all fire-rated partitions and poke-through floor and wall penetrations, to maintain continuity of fire-rated construction whether or not shown.
2. Install fire stop sealants and other fire stop system components in thicknesses recommended by manufacturer at all locations where poke-through penetrations occur, at all locations where other penetrations such as ducts, pipe, cables, cable trays, and conduit occur and at perimeter of all fire-rated walls.
3. Include all components of manufacturer's fire/smoke-stop systems for complete system responsibility installed in accordance with manufacturer’s written recommendations and specifications.

D. Board-type Perimeter Insulation:
1. Install perimeter insulation after concrete footings have been poured and before on-grade concrete slab work begins.
2. Remove projections that interfere with placing.
3. Apply single 2.0-foot-wide continuous band of insulation of required thickness and number of layers at slab-on-grade buildings whether or not shown. Stagger joints between layers of insulation and butt insulation tightly together.
4. Protect top surface of horizontal insulation from damage during concrete Work by applying protection course material recommended by insulation manufacturer.
5. On vertical surfaces, set units in adhesive applied in accordance with manufacturer’s instructions. Use type of adhesive recommended by manufacturer of board-type perimeter insulation.
6. Tape bottom edge of insulation before temporarily attaching insulation to wall with mastic.
7. Tape all joints in vertical wall insulation.
8. Protect insulation on vertical surfaces from damage during backfilling by applying protection course material recommended by insulation manufacturer. Set in adhesive in accordance with recommendations of insulation manufacturers and protection course material.

E. Cavity Wall Rigid Insulation Board:
1. Install exterior wall rigid insulation board after all concrete unit masonry Work is complete.

2. Apply single layer of insulation cut to fit snugly and uniformly and in continuous contact with edges of continuous masonry horizontal joint reinforcement over entire plane of the wall.
3. Apply exterior wall rigid insulation to exterior concrete unit masonry walls in areas shown or indicated as receiving masonry outer cavity wall wythes.
4. Set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of board-type cavity wall insulation.

F. Correcting Defective Work:
1. System components that are dislodged, damaged, expanded, broken, penetrated, or crushed by subsequent installation operations or damaged by detrimental weather shall be immediately replaced with undamaged material in compliance with the Contract Documents and properly protected as specified.
2. Only original installer shall repair or replace deteriorated or defective Work.

3.4 PROTECTION

A. Protection from Elements:
1. Protect all components of the Work from detrimental weather conditions. Do not allow building insulation materials to become wet or soiled, or covered with ice or snow. Provide continuous protection of materials against damage, wetting and moisture absorption and storing materials as specified
2. Work that cannot, for reasons acceptable to Engineer, be covered with complete construction system before onset of weather detrimental to the Work, shall be completely covered and protected in manner that deflects precipitation from building insulations without damaging adjacent Work.
3. Protect foam plastic building insulation from exposure to sunlight.

B. Protection During Construction:
1. Protect all components of the Work from construction operations including, but not limited to, backfilling, framing, and sheathing, aluminum siding, and concrete unit masonry Work, until work is completed and acceptable to Engineer.
2. Protect building insulations from damage and abuse by other contractors and installers until readiness for final payment.
3. Do not allow building insulations to come into contact with welding operations or other fire or ignition sources.
4. Do not allow construction traffic not associated with installation of building insulation in the area of building insulation Work. Protect the area from access by other installers and contractors until the building insulation Work has been incorporated into finished construction systems.

C. Building insulation that becomes wet, damaged, or deteriorated shall be promptly removed from the Site and replaced with materials conforming to this Section.

END OF SECTION 07 2105

SECTION 07 2216

ROOF BOARD INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all roof board insulation.
2. Types of products required include the following:
a. Extruded, pentane isomer blown, polyisocyanurate rigid board-type insulation.
b. Composite system of lightweight vermiculite insulating concrete with integral expanded polystyrene, rigid foam insulation board.
c. Miscellaneous materials and accessories.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the roof board insulation Work.
2. All framing for openings, edge angles, nailers, curbs and other items shall be in place before start of roof board insulation Work.
3. Coordinate finish of galvanized steel metal roof deck for acceptance by composite roof board insulation manufacturer.
4. Field-verify location of all roof penetrations, drain locations, and deck deflections.

C. Related Sections:
1. Section 06 10 53, Miscellaneous Rough Carpentry.
2. Section 07 53 23, Ethylene-Propylene-Diene-Monomer (EPDM) Roofing.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
1. American Society for Testing and Materials, (ASTM).
a. ASTM C 150, Specification for Portland Cement.
b. ASTM C 177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
c. ASTM C 203, Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
d. ASTM C 272, Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
e. ASTM C 303, Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
f. ASTM C 495, Test Method for Compressive Strength of Lightweight Insulating Concrete.
g. ASTM C 518, Test Method for Steady-State Thermal Transmission Properties by Means of Heat Flow Meter Apparatus.
h. ASTM C 550, Test Method for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation.
i. ASTM C 1289, Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

j. ASTM D 696, Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C with a Vitreous Silica Dilatometer.
k. ASTM D 1621, Test Method for Compressive Properties of Rigid Cellular Plastics.

2. ASTM D 1622, Test Method for Apparent Density of Rigid Cellular Plastics.
   a. ASTM D 1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
   c. ASTM E 96, Test Methods for Water Vapor Transmission of Materials.
3. Factory Mutual, (FM).
   a. FM Publication, Loss Prevention Data for Roofing Contractors, 1-29, Above-Deck Roof Components.
   b. FM Publication, Approval Guide.
4. Underwriters Laboratories, (UL).
   a. UL Building Materials Directory.

1.3 QUALITY ASSURANCE

A. Installer's Qualifications:
1. Roof board insulation Work shall be performed by the installer of the associated roofing for undivided responsibility.
2. Engage a single composite roof board insulation system installer, approved in writing by the manufacturer of the composite roof board insulation, who has qualified for appointment and has been trained by the manufacturer of the composite roof board insulation system and who is equipped to perform workmanship in accordance with both the requirements of the composite roof board insulation manufacturer and the membrane roof manufacturer so that there will be undivided responsibility for the performance of the composite roof board insulation Work.
3. Submit proof of acceptability of installer by manufacturer to Engineer.

B. Source Quality Control:
1. Obtain extruded polyiscoyanurate rigid board-type insulation from manufacturers who manufacture specified insulation using a blowing agent containing no chlorine-based compounds.
2. Engage a single manufacturer for each type of roofing insulation who shall provide the services of a technical representative to assist Contractor and Engineer by providing technical opinions on the adequacy of materials and methods of installation based on Shop Drawings approved by Engineer.
3. Provide such services during the time of delivery, storage, handling and installation of all roofing insulation.
4. The thicknesses shown are based on the thermal conductivity, k-value at 75°F specified for each material. Thicknesses of roof board insulation materials submitted by Contractor as "or equal" to specified materials shall have their thicknesses adjusted to provide the same thermal resistance as materials specified.

C. Erection Tolerances: Provide the following for composite roof board insulation:
1. In addition to filling the space between all metal deck flutes, provide minimum of 1/8-inch of insulating concrete over the top of the metal deck.
2. Finished system shall not pond water and shall provide a uniformly sloped surface to low point roof drains. If at any time up to the time of Final Acceptance the roof shows signs of ponding water, the composite roof board insulation system shall be repaired to provide uniform slope to drain, at no additional cost to Owner.

D. Requirements of Regulatory Agencies: Comply with fire-resistance ratings as required by governing authorities and building codes, and complies with the following roof board insulation requirements:
   1. Underwriters Laboratories requirements for roof deck constructions which are rated "UL Class A".
   2. Factory Mutual requirements for "Class 1-90" rated construction, for wind resistance.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Samples:
      a. Each fastener to be used in the Work.
      b. 12-inch by 12-inch sample of specified extruded and expanded rigid board-type insulation and composite insulation system.
   2. Shop Drawings:
      a. Field verified locations of all roof penetrations, drain locations, and deck deflections.
      b. Complete layout of all roof board insulation showing sizes, placement, number of courses and methods of fastening. Include statement that fastening method, location and density of fasteners have been approved by roof membrane manufacturer and comply with wind uplift requirements specified.
      c. Weights of all equipment to be used on roof.
      d. All required roof board insulation details approved by the roof board insulation manufacturer and the manufacturer of the respective roofing systems.
   3. Product Data:
      a. Manufacturer's specifications and installation instructions for each type of roof board insulation required. Include data substantiating that the materials comply with specified requirements.

B. Informational Submittals: Submit the following
   1. Certificates:
      a. Installer's qualifications.
   2. Site Quality Control Submittals:
      a. Submit Job Conditions Report, prepared by composite roof board insulation installer, as specified, and in addition, include a notarized statement from the full-time on-Site technical representative and installer that the composite roof board insulation system was installed according to manufacturer's written recommendations as shown on approved Shop Drawings.
   3. Source Quality Control Submittals:
      a. Laboratory test results for thermal resistance values based on ASTM C 177 or ASTM C 518 for actual composite roof board insulation system shown and specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Do not deliver insulation materials to the Site before time of installation.
   2. Deliver materials in manufacturer's original, undamaged packages or acceptable bulk containers.

B. Storage of Materials:
   1. Do not allow insulation materials to become wet or soiled, or covered with ice or snow.
   2. Protect plastic insulation from exposure to sunlight.

3. Protect plastic insulation against ignition.
4. Store packaged materials to protect them from the weather and physical damage.

C. Handling of Materials:
1. Comply with manufacturer's recommendations for handling, storage and protection.
2. Do not use cement which shows indication of moisture damage, caking or other signs of deterioration.

1.6 JOB CONDITIONS

A. Pre-Roofing Conference: Provide both a representative of the composite roof board insulation system manufacturer and the foreman of the installer who will actually work on this Project at the Pre-Roofing Conference specified in Section 07 5323, Ethylene-Propylene-Diene-Monomer (EPDM) Roofing.

B. Environmental Requirements:
1. Do not install roof board insulation when weather conditions are such that the deck is not completely dry, there is ice or snow on the deck, or where there is no assurance that the roof board insulation can be completely protected from the weather by the end of the day's Work.
2. For applications of composite roof board insulation system, when the temperature is expected to fall below 40°F, submit written installation recommendations of the composite insulation system manufacturer confirming acceptability of the conditions encountered. Contractor shall verify that composite roof board insulation system installed under such adverse weather conditions meet all material and performance requirements specified. Installer shall record actual conditions of installation, including intervals between system component placement, weather and temperature conditions, temporary uses of roof (if any) and other pertinent installation factors and include in Job Conditions Report submitted to Engineer.
3. Hot water is not available at the Site and shall be supplied by composite roof board insulation installer as required by installation conditions.
4. Potable water is not available at the Site and shall be provided by composite roof board insulation installer.

C. Protection:
1. Do not overload the building structure with the weight of stored materials or use of equipment.
2. Install temporary water cut-offs at the end of each day's Work to protect the roof board insulation. Remove the temporary water cut-offs upon resumption of the Work.

1.7 SEQUENCING

A. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the roofing membrane over the roof board insulation are at the Site and are ready to follow with this Work immediately (same day) after the roof board insulation Work.

B. Do not install any more rigid board-type roof board insulation each day than can be covered with complete roofing system by the end of that working day.

C. Follow composite roof board insulation manufacturer's written requirements for installation timing and sequencing of Work. Do not place more leveling slurry coat than can be completely covered

with insulation within thirty minutes nor more expanded polysytrene insulation than can be covered with insulating concrete within four hours of placing insulations.

1.8 GUARANTEE

A. The manufacturer of the composite roof board insulation system shall warrant to Owner that the roof board insulation will remain in a re-roofable condition, for a period of ten years, should the roof membrane require replacement; that the roof board insulation will remain in place even if the roof membrane sustains wind damage; and that the roof board insulation's actual resistance to heat flow will be at least 80 percent of the installed value, provided the roof remains leak free.

B. The thickness of the composite roof board insulation system, the maximum step between layers of expanded polystyrene rigid board insulation and the minimum slope-to-drain requirements shall not vary from what is shown, specified and approved.

1.9 SUBSTITUTIONS

A. Manufacturer of the primary roofing membrane systems shall be a manufacturer who finds the generic types of insulation specified herein as acceptable and bondable if installed according to the roofing manufacturer's standards for complete product and performance responsibility.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Extruded Polyisocyanurate Rigid Board Roof board insulation:
   1. Rigid, rectangular boards of extruded closed-cell polyisocyanurate complying with ASTM C 1289, Type II, with low water vapor permeability and laminated to heavy black (non-asphaltic) fiber-reinforced felt facers with one side of board containing perforated facers and the other side containing non-perforated facers.
   2. Provide a blowing agent with zero ozone depletion potential, such as pentane.
   3. Physical Properties: Provide the following:
      a. Minimum Compressive Strength, (at 10 percent deformation), ASTM D 1621: 25 psi minimum.
      b. Flame Spread, ASTM E 108: Class A.
      c. Smoke Development, ASTM E 84: 120 maximum.
      d. Vapor Transmission, ASTM E 96: 0.8 perms/inch.
      e. Thermal Resistance, ASTM C 518: 7/inch.
      f. Maximum Water Absorption, ASTM C 209: 0.10 percent by volume.
   4. Size: 48-inches by 96 inches by 2-inch thick.
   5. Number of Layers: As required by thickness of roof board insulation shown.
   6. Products and Manufacturers: Provide one of the following:
      a. ACUltra (Pentane Blown) Hydrocarbon ACFoam - II by Atlas Roofing Corporation.
      b. Or equal.

B. Composite Roof board insulation:
   1. Expanded Polystyrene Rigid Board: Provide the following board as a system component of the composite roof board insulation system for use beneath all membrane roofing:
      a. Rigid: 100 percent virgin expand polystyrene modified resin bead board with bead fusion of 80 percent minimum with no visible voids.

b. Molded blocks air dried for minimum of six weeks with less than 0.5 percent residual pentane prior to fabrication.
c. Size: 24-inches by 48-inches with pattern of 30 holes and 30 slots per board.
d. Dimension Tolerances, ASTM C 550:
1) Length: ±1/16-inch.
2) Width: ±1/16-inch.
3) Thickness: ±1/16-inch.
4) Squareness: ±1/16-inch.
5) Flatness: ±1/32-inch.

2. Insulating Concrete: Provide the following:
a. Portland Cement: ASTM C 150, Type I, II or III.
b. Vermiculite Aggregate: As recommended by system manufacturer.
c. Calcium Chloride: Not permitted.
d. Water: Potable, clean, and free from deleterious amounts of acid, alkali and organic materials.
e. Physical Properties: Provide the following physical properties for the insulating concrete design mix:
1) Minimum Compressive Strength, ASTM C 495: 300 psi.
2) Density at Placement: 60 to 68 pcf.
3) Oven Dry Density: 33 to 42 pcf.

3. Reinforcing Mesh: 2160-2-1619 galvanized mesh as recommended by the manufacturer of the composite roof board insulation.
4. Products and Manufacturers: Provide one of the following:
a. NVS and Insulperm Polystyrene Roof board insulation System by Siplast, Incorporated.
b. Or equal.

C. Miscellaneous Materials:
1. Adhesive for Bonding Insulation: The type recommended by the roof board insulation manufacturer, and complying with fire-resistance requirements.
2. Mechanical Anchors: The type recommended by the roof board insulation manufacturer for the type of deck used, and complying with fire and insurance rating requirements.
3. Mastic Sealer: Type recommended by roof board insulation manufacturer for bonding edge joints between units and filling voids.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and installer shall examine the substrate and the conditions under which the roof board insulation Work is to be performed, and notify Engineer, in writing, of any unsatisfactory conditions. Do not proceed with the roof board insulation Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Commencement of the Work shall be understood by Engineer to mean that all conditions are acceptable to the manufacturer's technical representative, Contractor and installer to provide acceptable Work under this Contract.

3.2 PREPARATION

3.3 INSTALLATION

A. General:
   1. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to Site conditions, consult manufacturer's technical representative for specific recommendations before proceeding. Incorporate recommendations into the Work only as approved by Engineer. Record all such discussions and the basis for discussions in Job Conditions Report.
   2. Coordinate heights of wood blocking to provide flush transition between roof board insulation and perimeter wood blocking.
   3. Extend roof board insulation full thickness as shown over entire surface to be insulated.
   4. Cut and fit tightly around obstructions, and fill voids with roof board insulation.

B. Board-Type Roof board insulation Units: Install rigid board-type roof board insulation according to FM 1-29 Wind Storm Resistance Classification specified, and as follows:
   1. Install wood nailers as required by roofing membrane manufacturer.
   2. Prime surface of concrete deck with asphalt primer at the rate of 3/4 gallons per 100 square feet, unless greater weight is required by roofing membrane system manufacturer, and allow primer to dry. Set each layer of roof board insulation in a solid mopping of hot roofing asphalt.
   3. Apply two courses of roof board insulation to make up the total required thickness under roofing.
   4. Install rigid board-type roof board insulation to form a continuous, uninterrupted plane between metal purlins installed perpendicularly to slope of metal deck, with all roof board insulation boards tightly butted together. Align top of roof board insulation boards flush with top surface of metal purlins or as shown for ventilated metal roof assemblies.
   5. Stagger the short-side edges of roof board insulation board in one direction with the two opposite sides of each roof board insulation board continuously supported on steel deck ribs, as close as possible to the center of the rib as practical, and with a minimum bearing width of 1-inch. Trim board edges if they veer off the rib center. Stagger joints in each succeeding layer from joints of previous layer a minimum of 6-inches in each direction.
   6. Coat edges of closed-cell (non-breathing) units with either adhesive or mastic sealer, and shove into place against installed units so that joints are filled and sealed.
   7. Extend roof board insulation full thickness as shown over entire surface of roofs.

C. Roof board insulation System:
   1. Place expanded polystyrene rigid board insulation into the slurry within thirty minutes of insulating concrete placement with joints staggered in a running bond pattern.
   2. Tightly butt all rigid boards together and install in a manner that provides full contact of slurry to board, and with adequate pressure to cause insulating concrete to enter the locking/keying openings of the rigid board.
   3. Install rigid boards in a stair-stepped configuration with maximum step down of 1-inch between boards, over entire plane of roof surface. Cut boards as required in order to maintain 2-inches of insulating concrete cover at insulation step in compliance with slope-to-drain and high point and low point elevations shown.
   4. Within four hours of rigid board placement, place 2-inches of insulating concrete over rigid boards and screed to a smooth, consistently dense, uniformly sloped plane to roof drains at low points. Ensure that all locking/keying openings in rigid board are completely filled with insulating concrete. Provide finish and other system features acceptable to membrane roofing installer.
   5. Include reinforcing mesh as part of the composite roof board insulation system to help control crack formation and distribute forces within the composite roof board insulation system.

6. Provide high and low point elevations shown. Provide smooth, uniformly sloped top of insulating concrete plane, sloped to drain at 1/4-inch per foot.

3.4 PERFORMANCE

A. Roof board insulation Work shall withstand the uplift forces of wind, as defined by the roofing guarantee. Refer to Section 07 53 23, Ethylene-Propylene-Diene-Monomer (EPDM) Roofing.

B. Failures of the composite roof board insulation Work in bond or anchorage to the substrate, or between courses of roof board insulation, or within the roof board insulation, will be considered failures of materials or workmanship under the Roofing Guarantee.

3.5 FIELD QUALITY CONTROL

A. Test the substrate for moisture content, by suitable means, wherever there is a possibility that exposed substrate has acquired moisture in excess of the maximum content for optimum application of the insulation, as determined by the manufacturer.

3.6 PROTECTION

A. Do not permit construction traffic over completed insulation Work, except as required for roofing.

B. Protect roof board insulation Work from exposure to moisture, damage and deterioration, primarily by prompt installation of roofing Work to be placed over the roof board insulation.

3.7 COMPOSITE ROOF BOARD INSULATION FIELD TESTING

A. Check cast density hourly at the point of placement. Include reports as part of notarized Job Conditions Report information and submit to Engineer.

B. Retain a minimum of four 3-inch by 6-inch cylinder material specimens for each day's pour. Protect specimens from damage and temperature extremes and test in accordance with ASTM C 495. Submit results of test as part of notarized Job Conditions Report and submit to Engineer.

3.8 INSPECTION AND ACCEPTANCE

A. Roof board insulation which has become wet, damaged, or deteriorated, as determined by Engineer, shall be promptly removed from the Site, even if already installed.

B. Correct all improperly sloped, chipped, cracked, improperly set, ridged or rough areas in the roof board insulation to provide substrate acceptable to roofing manufacturer and Engineer.

C. Final acceptance will be contingent upon the receipt by Engineer of a Job Conditions Report certifying conformance of the Work with the requirements of this Section and which includes all information requested by these Specifications.

END OF SECTION 07 2216

SECTION 07 4113

METAL ROOF PANELS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all labor, materials, equipment and incidentals required to furnish and install preformed, metal roof panels as shown and specified. The Work also includes:
   a. Providing openings in preformed, metal roof panels to accommodate the Work under this and other Sections and building into the preformed metal roof panels all items such as sleeves, inserts and all other items to be embedded in preformed metal roof panels for which placement is not specifically provided under other Sections.
2. The extent of preformed, metal roof panels Work is shown and is defined to include exterior preformed, prefinished metal roofing, cap and drip flashings, metal closures and all other associated trim and accessories.
3. The types of preformed, metal roof panels Work required include the following:
   a. Preformed metal roof panels.
   b. Miscellaneous fasteners, trim, flashings, closures, and accessories.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or embedded in, the preformed prefinished roof panels.

C. Related Sections:
1. Section 05 0533, Anchor Systems.
2. Section 05 1200, Structural Steel Framing.
3. Section 07 9200, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
1. American Society for Testing and Materials, (ASTM).
   a. ASTM A 167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
   b. ASTM A 653, Specification for Steel Sheet, Zinc-Coated, (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
   d. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
   e. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
   f. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
   g. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   h. ASTM D 4214, Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

i. ASTM E 283, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen.
j. ASTM E 331, Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference.
k. ASTM G 152, Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials.
l. ASTM G 153, Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials.
m. ASTM G 155, Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

2. Underwriters Laboratories, Incorporated, (UL).
   a. UL, Building Materials Directory.
   b. UL 580, Tests for Uplift Resistance of Roof Assemblies.
3. Ohio Building Code, (OBC).

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide company specializing in architectural sheet metal products with a minimum of ten years of experience.

B. Installer Qualifications:
   1. Engage a single installer regularly engaged in preformed metal roof panels installation and with experience in the erection of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to Engineer.

C. Component Supply and Compatibility: Obtain all preformed, metal roof panels panels and accessories from the same manufacturer.

D. Requirements of Regulatory Agencies:
   1. Comply with UL Construction No. 95 for Class 1-90 wind uplift rating.
   2. Ohio Building Code.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Samples:
      a. Samples of each type of preformed metal roof panels panel and trim complete with factory-applied finish, two foot long by full-width. Samples will be reviewed by Engineer for pattern, texture and color only. Compliance with other requirements is the exclusive responsibility of Contractor.
      b. One of each type fastener employed, with statement of intended use. Samples will be reviewed by Engineer for material and color only. Compliance with other requirements is the exclusive responsibility of Contractor.
      c. Complete selection of manufacturer's standard and custom colors.
   2. Shop Drawings:
      a. Copies of manufacturer's specifications, standard and custom detail drawings and installation instructions for preformed metal roof panels, supports and trim. Submit manufacturer's standard warranty on factory-applied finish of preformed metal roofing panel.

b. Profiles of preformed prefinished roofing panel units, and the details of forming, jointing, gaskets (if any), supports, anchorages, trim, flashing, and accessories. Show details of weatherproofing at edges, terminations and penetrations of the preformed prefinished roof panel Work. Show 1/4-inch to the foot scale layout and elevations of entire Work. Show all details at 3-inch to the foot scale, indicating all internal components and intersection members, details and special fabrication techniques.

3. Delegated Design Submittals:
   a. Submit design computations signed and sealed by a Registered Professional Structural Engineer licensed in the State of Ohio to verify structural adequacy of members and connections, for review with Shop Drawings.

B. Informational Submittals: Submit the following:
1. Source Quality Control Submittals:
   a. Test Reports: Submit for approval certified laboratory tests reports for required performance tests:
      1) Air Infiltration: ASTM E 283.
      2) Water Infiltration: ASTM E 331.
      3) Wind Uplift: UL-90 rated wind up-lift resistance requirement specified in UL 580 test.
      4) Formability: ASTM D 522.
      5) Weathering: ASTM G 152, ASTM G 153, and ASTM G 155.
      6) Chalking Resistance: ASTM D 4214.
      7) Color Change: ASTM D 2244.
      8) Salt Spray: ASTM B 117.
      9) Abrasion: ASTM D 968.
      10) Humidity: ASTM D 2247.
2. Qualification Statements
   a. Installer's Qualifications
3. Certificates:
   a. Submit for approval written certification prepared, signed and sealed by a Registered Professional Structural Engineer, licensed in the State of Ohio, verifying that the design meets indicated loading requirements and codes of authorities having jurisdiction.

1.5 GUARANTEES:

A. Submit manufacturers and Contractor's written guarantees as specified, herein.

B. Site Quality Control Submittals:
1. Submit results of testing and inspection performed in the field by Manufacturer's technical representative.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver preformed metal roof panels paneling and all accessories dry and undamaged, with manufacturer's protective coating intact.
2. Deliver preformed metal roof panels panels in bundles with banded wood surrounds and end caps intact.

B. Storage of materials:
   1. Store preformed prefinished roof paneling and accessory materials in a manner that will protect the panels from exposure to sun and condensation; with good air circulation around each piece.
   2. Store preformed prefinished roof paneling and accessory materials in an area protected from dirt, damage and weather.
   3. Do not store in contact with concrete or other materials that might cause corrosion.

C. Handling of Materials:
   1. Do not subject preformed prefinished roof paneling and accessory materials to bending or stress.
   2. Do not damage edges or handle material in a manner that will cause scratches, warps or dents.

1.7 GUARANTEE

A. Provide manufacturer's standard warranty on the coil coated polyvinylidene fluoride based coating specified, herein.

B. Guarantee that the polyvinylidene fluoride based coating meets all criteria specified and will not spall, check, craze, peel or otherwise lose adhesion for a period of twenty years from the date of Final Acceptance, to the extent that such shall create unsightly conditions or otherwise impair the intended architectural qualities of the building.

C. In the event that the coil coated polyvinylidene fluoride based coating fails to meet the specified standards the manufacturer shall, at their own expense, replace or field paint, at the direction of the Engineer, all areas affected by the failure. In the event that repainting is selected, it shall be done at mutually agreeable intervals throughout the term of the warranty.

D. The warranty does not apply where failure is caused by accidents, or external conditions or forces beyond the control of the manufacturer.

E. Provide a written guarantee agreeing to replace preformed metal roof panels panel Work which fails in material or workmanship within one year of the date of Final Acceptance. Failure of materials or workmanship shall include, but is not limited to, deterioration in excess of normal weathering and lack of water or weather tightness. Imperfections, by reason of defective materials, workmanship or arrangement of the various parts shall be made good to the satisfaction of the Owner, at the Contractor's expense.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
   1. Provide preformed, prefinished roofing panels, framing and accessories that comply with the following minimum performance characteristics:
      a. Wind loading shall be 110 miles per hour, unless heavier loading is required by the Uniform Building Code.
   2. Anchorage system shall be designed so that panels are free to move for expansion and contraction and so that individual panels may be removed without disturbing adjacent panels.

3. Form panels in lengths, as required.

2.2 MATERIALS

A. Preformed Prefinished Metal Roof Panels:
   1. Custom-fabricated, roll-formed, 22 gauge minimum, but in no case lighter than required to meet deflection requirements. Panels shall be hot dipped galvanized ASTM A 653 Grade C steel panels.

B. Flashing and Trim:
   1. Provide flashings and sheet metal contour closure trim components, indicated or required for a complete installation, as part of the preformed metal roofing panels Work, including cap flashings, base and drip flashings, closure and batten cleats, panel stops and closures, surrounds at openings, soffits, and similar components of the Work.
   2. Provide factory fabricated trim components.
   3. Except as otherwise shown or specified, match the material, gage, and finish of the preformed metal roof panels.
   4. Provide all concealed fasteners for flashing and trim Work.

C. Miscellaneous Materials:
   1. Provide manufacturer's custom, stainless steel, self-tapping concealed fasteners, and hold-down cap assemblies, and other components needed for a complete, permanently weatherproof installation. Provide stainless steel complying with ASTM A 167.
   2. All fasteners used at all locations shall be stainless steel.
   3. Snowguards: Fabricate from 1-1/2 inch x 2 inch x 3/16 inch Aluminum Angle 6061-T6. Vertical leg factory notched for vertical panel legs. Fasteners for the compression clamp attachment shall be 1/4 inch diameter stainless steel bolts, nuts, and washers. Shop paint angles to match roofing color.
   4. Sealant: Provide manufacturer's standard factory applied elastomeric sealant for use within this Section of the Work, where applicable.

D. Provide strippable film of liquid applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed before installation.

E. Manufacturers: Provide products of one of the following:
   1. Merchant and Evans.
   2. Fabral.
   3. Centria.
   4. Or equal.

2.3 PREFORMED PREFINISHED ROOFING PANEL FABRICATION

A. General:
   1. Comply with the dimensions, profile limitations, gages and fabrication details as shown or specified.
   2. Prefabricate all components of the system at the factory, ready for field assembly of preformed prefinished roofing panels, joint cleat, anchor clips, trim and accessories.
   3. Fabricate components and assemble units to comply with the performance requirements specified for the completed installation of the Work.
   4. Provide panels with 2 ribs per panel.

5. Size: Provide 2 inch high seam by 18 inches wide panels.
6. Panels are to be mechanically seamed with factory applied sealant.

2.4 PREFORMED ROOF PANEL COATINGS

A. Finish Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating, prior to fabrication of the preformed, metal roof panels panels. Comply with the following:
   1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
   2. Prepare a chemical conversion coating on the metal panel surface using phosphates or chromates followed by a cold water rinse. Seal with a chromic acid rinse and dry, except where panel manufacturer recommends another method to achieve greater coating reliability.
   3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.25 to 0.35-mils.
   4. Apply finish coating over the primer by roller coating and fuse at a peak metal temperature of 470°F for a dry film thickness of 0.7 to 0.9-mils so that the total dry film is approximately 0.95 to 1.25-mil thick.
   5. Color shall be selected by Engineer.

B. Products and Manufacturers: Provide one of the following:
   1. Kynar 500 Fluropon by DeSoto, Incorporated.
   2. Kynar 500 Duranar by PPG Industries.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and installer must examine the alignment of the substrate framing before erection of the preformed metal roof panels Work begins and notify the Engineer, in writing, of unsatisfactory conditions. Do not proceed with the preformed metal roof panels panel Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.2 PREPARATION

A. Wherever possible, take field measurements, prior to completion of shop fabrication and finishing of preformed metal roof panels. Do not delay job progress. Allow for trimming where final dimensions cannot be established before fabrication.

3.3 INSTALLATION

A. Comply with preformed metal roof panels panel manufacturer's instructions for assembly, installation, erection and seaming of preformed metal roofing panel Work.

B. Install light gauge metal framing in accordance with the manufacturer's instructions.

C. Anchor component parts of preformed metal roof panels panel and light gauge metal framing securely in place providing for necessary thermal and structural movement.

D. Do not exceed fastener spacing recommended by the preformed metal roof panel manufacturer.

E. All fasteners must be long enough to penetrate through the entire roof panel assembly and extend through the structural support a minimum of 1/2-inch.

F. Fasten flashings and accessories 12-inches on center.

G. Do not use exposed fasteners on the exterior panel faces.

H. Drive all fasteners normal to the surface and to a uniform depth.

I. Install sealants for the preformed metal roof panels panel Work as specified, and as required for watertight performance. Comply with sealant manufacturer's instructions for installation and curing.

J. Do not fabricate flashings, closures and associated trim at the Site.

K. Install all special flashing and trim shapes, and calking compounds required to maintain complete weathertightness.

L. Comply with roofing panel manufacturer's instructions and recommendations.

3.4 FIELD QUALITY CONTROL

A. Determine conformity of preformed prefinished metal finish to this Section as follows:
   1. The manufacturer of the preformed, metal roof panels shall set aside a labeled sample of the preformed, metal roof panels from each production lot of panels at the Site. Protect sample preformed metal roof panels from weather.
   2. Make sample preformed metal roof panels available at all times, for comparison with installed preformed metal roof panels, as requested by the Owner, for the full time period of the warranty.
   3. Make color comparison measurements with a Hunter Tristimulus Color Difference Meter employing methods of computation in use at the National Bureau of Standards conforming to ASTM D 2244.
   4. Manufacturer's technical representative shall visit the Site to perform field inspection of the roof panels, flashing and other system components at the start and at Substantial Completion of Work prior to issuance of warranty, as a minimum, and as otherwise requested by the Engineer. Each inspection visit shall include a written review of the entire installation to date, signed by the manufacturer's technical representative and submitted to the Engineer. Contractor shall notify the Engineer a minimum of two working days prior to the Site visit by the manufacturer's technical representative.

3.5 ADJUSTMENT AND CLEANING

A. Set preformed, metal roof panels plumb, level, and true to line, without warp or rack.

B. Clean exposed surfaces of preformed metal roof panels panel Work promptly after completion of installation. Comply with recommendations of the preformed, metal roof panels panel manufacturer.

C. Leave preformed metal roof panels panel and flashing perfectly flat, free from dents, burrs, scratches, holes or other blemishes.

D. Do not erect components which have become scarred, chipped or otherwise damaged or defaced.

E. Remove and replace with new material preformed, metal roof panels panels and component parts of the Work, including finish, which have been damaged beyond successful repair, as directed by the Engineer, in writing. Repair minor damage.

F. Do not use roofing panel sheets, trim members, and flashing sheets, in which holes have been made in locations where fasteners are not required.

G. At the completion of the Work, clean or replace adjacent work, marred by the Work of this Section.

H. Remove all materials and debris and leave the Site of the Work in clean condition.

END OF SECTION 07 4113

SECTION 07 6200

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install sheet metal flashing and trim.
   2. The Work also includes:
      a. Providing openings in sheet metal flashing and trim to accommodate the Work under this and other Sections and building into the sheet metal flashing and trim all items such as sleeves, anchor bolts, inserts and all other items to be embedded in sheet metal flashing and trim for which placement is not specifically provided under other Sections.
   3. Extent of the sheet metal flashing and trim is shown.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the sheet metal flashing and trim Work.
   2. Work advanced without sheet metal flashing and trim items that are specified to be cast-in-place or built-in-place as the Work advances, shall be stopped, demolished and rebuilt incorporating specified sheet metal flashing and trim Work, at no additional cost to Owner.

C. Related Sections:
   1. Section 03 3000, Cast-In-Place Concrete.
   2. Section 04 0505, Unit Masonry Construction.
   3. Section 07 4162, Metal Roof Panels.
   4. Section 07 9200, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. The Aluminum Association, (AA).
      a. AA, ASD-1 - Aluminum Standards and Data.
      b. AA, DAF-45 - Designation System for Aluminum Finishes.
      c. AA, SAA-46 - Anodized Architectural Aluminum.
   2. American Society for Testing and Materials, (ASTM).
      a. ASTM A 480, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
      b. ASTM A 666, Specification for Annealed or Cold-Worked Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar.
      c. ASTM B 29, Specification for Refined Lead.
      d. ASTM B 32, Specification for Solder Metal.
      e. ASTM B 101, Specification for Lead-Coated Copper Sheet and Strip for Building Construction.
      f. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
      g. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

h. ASTM B 370, Specification for Copper Sheet and Strip for Building Construction.
i. ASTM B 749, Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
j. ASTM D 395, Test Methods for Rubber Property-Compression Set.
k. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers - Tension.
l. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
m. ASTM D 523, Test Method for Specular Gloss.
n. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
o. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
p. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
q. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
r. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
s. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
t. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
u. ASTM D 3363, Test Method for Film Hardness by Pencil Test.
v. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.

3. Factory Mutual Engineering Corporation, (FM).
   a. FM Loss Prevention Data for Roofing Contractors, 1-49 - Perimeter Flashing.
4. National Roofing Contractors Association, (NRCA).
   a. NRCA, Low-Slope Membrane Roofing Construction Details Manual.
5. Sheet Metal and Air Conditioning Contractors National Association, Incorporated, (SMACNA).
   a. SMACNA 1013, Architectural Sheet Metal Manual.
6. The Society for Protective Coatings, (SSPC).
   a. SSPC - Paint 12, Cold Applied Asphalt Mastic (Extra Thick Film).

1.3 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single installer who is a recognized flashing and trim installer, skilled and experienced in the type of flashing and trim Work required, and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the Work. Submit name and qualifications to Engineer along with at least three successfully completed Projects including names and telephone numbers of owners, architects and engineers, responsible for the project and the approximate contract price for flashing and trim work.

B. Source Quality Control:

1.4 SUBMITALS

A. Action Submittals: Submit the following:
   1. Samples:

a. 12-inch square samples of specified sheet metal flashing and trim metals.
b. Each item of gravel stop and coping system, demonstrating assembly of system joint components and fasteners, securely mounted to substrate simulating actual installation in the Work.
c. Polyvinylidene fluoride manufacturer's color samples for final selection by Engineer. After initial selection of colors by Engineer from manufacturer's color charts, submit Engineer's preliminary color choices on actual samples of metal substrate for final color selections by Engineer.
d. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is the responsibility of Contractor.

2. Product Data:
   a. Copies of manufacturer's specifications, installation instructions and general recommendations for sheet metal flashing and trim required. Include manufacturer's data substantiating that the materials comply with the requirements.
   b. Submit full selection of manufacturer's standard, custom and premium color charts.
3. Shop Drawings:
   a. Drawings showing the manner of forming, jointing and securing flashings and trim. Show fully dimensioned joint details and waterproof connections to adjoining Work and details at obstructions and penetrations.
   b. Drawings showing the coordination of the Work of this Section with Section 04 0505, Unit Masonry Construction, and Section 07 4113, Metal Roof Panels. Provide detailed Shop Drawings showing large scale details of sections and profiles of all sheet metal flashing and trim to be used in the Work, with all items, including fastener locations, cleats and other miscellaneous accessories necessary to complete the Work, fully dimensioned, properly located, quantified and presented such that sequence of installation is acceptable to each roofing system and adjacent construction material installer.

B. Informational Submittals: Submit the following:
1. Qualifications Statements:
   a. Installer's qualifications

C. Closeout Submittals: Submit the following:
1. Guarantee:
   a. Submit guarantee as specified in section 1.7
2. Warranty
   a. Submit warranty as specified in section 1.7

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Deliver sheet metal flashing and trim materials in manufacturer's original, unopened, and undamaged containers and rolls, with labels intact and legible, indicating compliance with approved Shop Drawings.
2. Items delivered in broken, damaged, rusted, or unlabeled condition shall immediately be removed from Site and not offered again for approval by Engineer.

B. Storage of Materials:
1. Store materials in an area undercover and protected from construction traffic.
2. Store materials in same package in which they were shipped, off the ground and on platforms protected from dirt and other contamination.

3. Store in a manner which does not permit water to remain on sheet metal flashing and trim materials and system components.

C. Handling of Materials:
1. Protect sheet metal flashing and trim from dents, scratches, warps and bends.
2. Remove strippable protective film, immediately proceeding installation of each system component.

1.6 JOB CONDITIONS

A. Scheduling:
1. Do not proceed with sheet metal flashing and trim Work until curb and substrate construction, cant strips, blocking, reglets and other construction to receive the Work is completed.
2. Deliver materials to the Site in sufficient quantities to ensure uninterrupted progress of the Work.
3. Schedule the installation of sheet metal flashing and trim to coincide with the installation of built-up bituminous roofing, waterproofing, drains, piping, blocking, nailers, reglets, framing at openings, curbs, parapets and other adjoining and substrate Work.
4. Proceed with and complete the Work only when materials, equipment and knowledgeable tradesmen, required for the installation of sheet metal flashing and trim, are at the Site and are ready to follow, and integrate sheet metal flashing and trim Work with roofing Work, in order to maintain watertight conditions.

1.7 GUARANTEE

A. Provide coping and cap flashing manufacturer’s fifteen year warranty against blow-off, leak, or premature membrane failure in winds of up to 110 miles per hour.

B. Provide manufacturer's twenty-year warranty on the specified coil coated polyvinylidene fluoride based coating.

C. Guarantee that the polyvinylidene fluoride based coating meets all criteria specified and will not spall, check, craze, peel or otherwise lose adhesion for a period of twenty years from the date of installation, to the extent that such shall create unsightly conditions or otherwise impair the intended architectural qualities of the building.

D. In the event that the coil coated polyvinylidene fluoride based coating fails to meet the specified standards the manufacturer shall, at their own expense, replace or field paint, at the discretion of Owner, all areas affected by the failure. In the event that repainting is selected, it shall be done at mutually agreeable intervals throughout the term of the warranty.

E. The warranty specified shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

F. The warranty does not apply where failure is caused by accidents, or external conditions or forces beyond the control of the manufacturer.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Sheet metal flashing and trim shall be permanently watertight, and not deteriorate in excess of manufacturer's published limitations.
   2. Snap-lock coping shall be detailed, fabricated and installed to provide a minimum of FM 1-90 wind up-lift resistance and require no exposed fasteners of any kind.
   3. Comply with fabrication details recommended by FM, SMACNA, NRCA and the requirements of the sheet metal flashing and trim manufacturer, and as shown on approved Shop Drawings.

2.2 MATERIALS

A. Metal Sheet metal flashing and trim:
   1. Stainless Steel Sheet metal flashing and trim: Provide 26 gage sheet stainless steel, Type 316, complying with ASTM A 666, with No. 2D dead soft, fully annealed finish, unless required to be harder temper for proper forming and performance for application indicated.
   2. Lead Sheet metal flashing and trim: Provide sheet formed from common desilverized pig lead complying with ASTM B 29 and ASTM B 749; weighing 6.0 pounds per square foot.
   3. Aluminum Sheet metal flashing and trim: Provide aluminum complying with ASTM B 209, alloy 3003, temper H14. Provide sheet aluminum 0.032-inches thick with AA-C22A41 finish.

B. Elastic Sheet Flashing:
   1. Polychloroprene synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
      a. Hardness, ASTM D 2240: 50 to 70 Shore A.
      b. Tensile Strength, ASTM D 412: 1500 psi.
      c. Tear Strength, ASTM D 624: 120 pounds per linear inch.
      d. Elongation, ASTM D 412: 300 percent.
      e. Brittleness Temperature, ASTM D 746: -30°F.
   2. Butyl synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
      a. Hardness, ASTM D 2240: 50 to 70, Shore A.
      b. Tensile Strength, ASTM D 412: 1200 psi.
      c. Tear Strength, ASTM D 624: 200 pounds per linear inch.
      d. Elongation, ASTM D 412: 300 percent.
      e. Brittleness Temperature, ASTM D 746: -30°F.
   3. Ethylene-propylene-diene monomer synthetic rubber sheet, 1/16-inch thick, black, with the following physical properties:
      a. Hardness, ASTM D 2240: 50 to 70, Shore A.
      b. Tensile Strength, ASTM D 412: 1400 psi.
      c. Tear Strength, ASTM D 624: 125 pounds per linear inch.
      d. Elongation, ASTM D 412: 300 percent.
      e. Brittleness Temperature, ASTM D 746: -75°F.

C. Flashing Reglets:
   1. General:
      a. Provide snap-lock type reglets of Type 304 stainless steel, 0.020-inches minimum thickness.

b. Provide reglets that engage counterflashing by use of a snap-lock or spring-lock profile. System shall employ only mechanical interlocking features for securing counterflashing in reglet, without the need for clips or screws.
c. Provide manufacturer's standard Type 304 stainless steel spring-lock profile flashing, 5-1/8-inches high, designed to incorporate a positive air break and to engage spring-lock reglet flange.
d. Provide reglets with 1-inch end laps and spring-lock flashing with 3-inch end laps.

2. Cast-In-Place Reglets: Provide, cast-in-place reglets for concrete, with manufacturer's standard foam backer rod to prevent cement from entering reglet.
3. Provide reglet with a vertical snap-lock engagement slot, 1-inch high by 1/2-inch deep with connector alignment clips and special staples for securing to formwork.
4. Products and Manufacturers: Provide one of the following:
5. Type CO Concrete Reglet by Fry Reglet Corporation.
6. Or equal.
7. Built-In-Place Masonry Reglets: Provide built-in-place reglets for masonry installation with top flange 4-inches wide to penetrate the first wythe of brick.
   a. Provide reglets without exposed fasteners of any kind. Provide engagement flange 1-1/8-inch high by 1/2-inch wide with snap-lock profile designed to pressure-lock counterflashing in place.
   b. Products and Manufacturers: Provide one of the following:
      1) Type MA-4 Masonry Reglet by Fry Reglet Corporation.
      2) Or equal.

D. Miscellaneous Materials:
1. Burning Rod for Lead: Same composition as lead sheet.
2. Solder for Copper: ASTM B 32, 50 percent tin and 50 percent lead, used with rosin flux.
3. Solder for Stainless Steel: ASTM B 32, 60 percent tin and 40 percent lead alloy grade 60A, used with an acid flux of the type recommended by the stainless steel manufacturer. Use a non-corrosive rosin flux over tinned surfaces.
4. Stainless Welding Rods: Type recommended by stainless steel sheet manufacturer for the type of metal sheets furnished.
5. Nails, Screws and Rivets: Same material as flashing sheet, or as recommended by manufacturer of flashing sheet.
6. Cleats: Same metal and gage as sheet being anchored, 2-inches wide, punched for two anchors.
7. Bituminous Coating: SSPC-Paint 12, cold-applied solvent-type bituminous mastic coating for application in dry film thickness of 15-mils per coat.
8. Sealants: Refer to Section 07 9200, Joint Sealants.

2.3 FABRICATION

A. Fabricated Metal Flashing: Shop-fabricate metal sheet metal flashing and trim to comply with profiles and sizes shown, and to comply with manufacturer's recommended details. Except as otherwise shown or specified, provide soldered flat-lock seams, and fold back metal to form a hem on the concealed side of exposed edges. Comply with metal producers' recommendations for tinning, soldering and cleaning flux from metal.

B. Fabricated Elastic Flashings: Shop-fabricate elastic flashing to comply with profiles and sizes shown and to comply with elastomeric material manufacturer recommendations.

C. Where fabricator does not recommend grinding welds smooth, comply with SMACNA formed metal details requiring double-lock seamed construction.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and installer shall examine the substrate and the conditions under which the sheet metal flashing and trim Work is to be performed, and notify Engineer, in writing, of unsatisfactory conditions. Do not proceed with sheet metal flashing and trim Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

A. Before installing sheet metal flashing and trim, verify shapes, and dimensions to be covered.

B. Prepare substrates as recommended by the sheet metal manufacturer.

3.3 INSTALLATION

A. General:
   1. Separate dissimilar metals from each other by painting each metal surface in the area of contact with a heavy application of bituminous coating, or by other permanent separation as recommended by the manufacturers of the dissimilar metals. Comply with the following:
      a. Separate stainless steel from dissimilar metals, including regular steel and iron, and from cementitious materials by a course of roofing felt wherever possible. Where felt application is not possible, coat the stainless steel or the other material with a 15-mil bituminous coating. Where felt is applied under sheets which will be soldered or welded, cover felt with a course of building paper before installing stainless steel. Comply with manufacturer's recommendations for other forms of protection of the stainless steel against corrosion.
   2. Provide thermal expansion for running trim, flashing, valleys, and other items exposed for more than 15 feet-0 inches continuous length. Maintain a watertight installation at expansion seams. Locate expansion seams as shown or, if not shown, at the following maximum spacing for each general flashing use:
      a. Valleys: Midway between drains (at high points in slopes), but in no case more than 30 feet-0 inches apart, except as otherwise shown.
      b. Sheet metal flashing and trim: At 10 feet-0 inch intervals and 2 feet-0 inch each side of corners and intersections.
   3. Fabricate and install Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat flat-locked seams with minimum exposure of solder, welds and sealant. Except as otherwise shown, fold back the sheet metal to form a hem on the concealed side of exposed edges. All exposed edges of all sheet metal flashing shall be hemmed not less than 1/2-inch wide.
   4. Conceal fasteners and expansion provisions wherever possible in exposed Work, and locate so as to minimize the possibility of leakage. Cover and seal Work as required for a watertight installation.

a. Provide cleat-type anchorages for metal flashings and trim wherever practical, arranged to relieve stresses from building movement, and thermal expansion and contraction.

5. On vertical surfaces lap two-piece flashings a minimum of 4-inches.
6. On sloping surfaces, for slopes of not less than 6-inches in 12-inches, lap unsealed flashings a minimum of 6-inches. For slopes less than 6-inches in 12-inches use soldered flat locked seams.
7. For embedment of metal flashing flanges in built-up bituminous roofing or composition flashing or stripping, extend flanges for a minimum of 4-inches embedment.

B. Installation of Stainless Steel Sheet metal flashing and trim:
1. Tin the edges of plain stainless steel to be soldered, for a width of 1-1/2-inches, using solder for stainless steel and acid flux. Remove every trace of acid flux residue from the metal promptly after tinning or soldering.
2. Where welded joints are shown, provide upturned, 1/2-inch wide hooked flanges, and weld between adjoining sheets; lay seam flat.

C. Installation of Lead Sheet metal flashing and trim:
1. Where prefabricated units of lead flashing are to be set in felts the under side may be coated with roofing cement.
2. Cut and shape lead sheets in place with minimum of 1-inch lapped joints, and form bends and folds to provide corners and intersections as shown. Shave or wire-brush joint areas immediately before sealing joint.
3. Burn joints in lead sheets to provide true welded construction, exercising care to avoid reduction of sheet thickness.

D. Installation of Aluminum Sheet metal flashing and trim: Bed base members and flashings of aluminum in roofing cement. Comply with manufacturer's instructions for installation and anchorage of units. Provide gasket-type washers under exposed screw and bolt heads. Shim and seal under units as required to provide continuous, level, plumb and true lines.

E. Installation of Elastic Sheet metal flashing and trim:
1. Bond elastic sheet metal flashing and trim sheets to vertical substrates and to other surfaces as indicated or recommended by sheet manufacturer, and seam the end joints.

F. Installation of Reglets and Reglet Counterflashing:
1. For installation of built-in-place masonry reglets refer to Section 04 0505, Unit Masonry Construction.
2. Install surface-mounted reglets complying with manufacturer's written instructions to produce a watertight installation. Use sealant specified in Section 07 9200, Joint Sealants.
3. Install counterflashing with positive pressure against base flashing and reglet and with air break at mid-point to prevent capillary action. No screws or exposed fasteners shall be permitted in the finished Work except those required at each pre-punched hole for surface-mounted reglet attachment.
4. End lap counterflashing horizontally a minimum of 3-inches.

3.4 FIELD QUALITY CONTROL

A. Polyvinylidene Fluoride Based Coatings: Determine conformity of sheet metal flashing and trim Work requiring painted finish to these Specifications as follows:

1. The manufacturer of the sheet metal flashing and trim Work shall set aside and label samples of each component of the sheet metal flashing and trim Work from each production lot for the Project. Protect samples from weather.
2. Make samples of sheet metal flashing and trim Work available at all times, for comparison with installed sheet metal flashing and trim Work as requested by Owner, for the full time of the warranty.
3. Make color comparison measurements with a Hunter Tristimulus Color Difference Meter employing methods of computation in use at the National Bureau of Standards conforming to ASTM D 2224.

3.5 ADJUSTMENT AND CLEANING

A. Protect sheet metal flashing and trim until Final Acceptance of the Work.

B. Do not permit workmen, or others, to step directly on flashing sheets in place, or to place or move equipment over sheet metal flashing and trim surfaces. Protect surfaces during installation of permanent covering work and adjoining Work.

C. Neutralize excess flux as the Work progresses with five percent to percent washing soda solution and rinse thoroughly.

D. Clean exposed surfaces of every substance which is visible or might cause corrosion or prevent uniform oxidation of the metal surfaces. Exercise extreme care to remove fluxes and ferrous metal particles, including welding splatter and grinding dust.

END OF SECTION 07 6200

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SECTION 07 9200

JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install joint sealants.
   2. Extent of each type of calking and sealant is shown or indicated and includes the following:
      a. Interior and exterior joints in equipment and construction systems not filled by another material, and that are not required to be open for operation.
      b. Exposed-to-view joints of all fire-rated sealants.
      c. Joints specified to be recalked.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before joint sealants.
   2. Coordinate final selection of joint sealants so that materials are compatible with all calking and sealant substrates specified.

C. Related Sections:
   1. Section 03 1500, Concrete Accessories.
   2. Section 04 0519, Masonry Anchorage and Reinforcing.
   3. Section 04 0505, Unit Masonry Construction.
   4. Section 07 2105, Building Insulation.
   5. Section 08 8100, Glass Glazing.
   6. Section 09 5113, Acoustical Panel Ceilings

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
   2. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   3. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
   4. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
   5. ASTM C920, Specification for Elastomeric Joint Sealants.
   6. ASTM C1021, Practice for Laboratories Engaged in Testing Building Sealants.
   7. ASTM C1087, Test method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
   8. ASTM C1193, Guide for Use of Joint Sealants.
   9. ASTM C1247, Practice for Durability of Sealants Exposed to Continuous Immersion in Liquids.
   10. BAAQMD Regulation 8, Rule 51.

11. FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
12. FS TT-S-00230 Sealing Compound: Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
13. NSF/ANSI Standard 61, Drinking Water System Components - Health Effects.
14. SCAQMD Rule 1168.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Engage a single installer, approved by product manufacturer, regularly engaged in calking and sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of Work required.
   2. Testing Laboratory:
      a. Furnish services of independent testing laboratory qualified according to ASTM C1021, for conducting testing required.

B. Component Supply and Compatibility:
   1. Obtain materials only from manufacturers who will, if required:
      a. Furnish at the Site services of a qualified technical representative to advise installer of proper procedures and precautions for using materials.
      b. Test joint sealants for compatibility with substrates for conformance with FS-TT-S-00227, and recommend remedial procedures as required.
   2. Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Shop Drawings and other approved submittals.

C. Product Testing: Provide test results of laboratory pre-construction compatibility and adhesion testing, as specified in Article 3.1 of this Section, by qualified testing laboratory, based on testing of current sealant formulations within a 36-month period preceding the Notice to Proceed for the Work.
   1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920 and, where applicable, to other standard test methods.
   2. Test other joint sealants for compliance using specified post-construction field adhesion test.

D. Mock-ups:
   1. Prior to installing joint sealant Work but after Engineer's approval of Samples, provide Sample of each type of calking and sealant in areas selected by Engineer to show representative installation of calkings and sealants. Obtain Engineer's approval of visual qualities of mock-ups before starting calking and sealant Work. Retain and protect mock-ups during construction as a standard for judging completed calking and sealant Work. Do not alter or destroy mock-ups until so allowed by Engineer.
   2. Perform the following testing on calking and sealant mock-up, as specified in this Section: Post-construction field adhesion testing and water leak test.
   3. Work that does not comply with test requirements on Sample areas will be considered defective.

E. Pre-installation Conference:
   1. Prior to installing joint sealants and associated Work, schedule and meet at the Site with calking and sealant installer, calking and sealant manufacturer's technical representative, other trades involved in coordinating with calking and sealant Work, Engineer, and Owner. Record discussions of pre-installation conference and decisions, agreements, and disagreements, and furnish copy of record to each party attending conference. Review foreseeable methods and procedures related to calking and sealant Work, including reviewing:
      a. Required submittals, both completed and yet to be completed.
      b. Status of test reports.
      c. Mock-up construction results.
      d. Status of substrate and similar considerations.
      e. Each major calking and sealant application required.
      f. Availability of products, tradesmen, equipment, and facilities required for avoiding delays.
   2. Reconvene conference at earliest opportunity if additional information must be developed to conclude subjects under consideration.
   3. Record revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of joint sealants installation, indication each specific surface where calking or sealants are to be provided and the material proposed for each application.
   2. Product Data:
      a. Copies of manufacturer's data sheets including color charts, specifications, recommendations, and installation instructions for each type of sealant, calking compound, and associated miscellaneous material required. Include manufacturer's published data, indicating that each product complies with the Contract Documents and is intended for the applications shown or indicated.
      b. Product test reports.
   3. Samples:
      a. Each type of actual cured material of each calking and sealant specified, in each of manufacturer's standard colors.
      b. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is responsibility of Contractor.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certify that materials are suitable for intended use and materials meet or exceed requirements of the Contract Documents.
      b. Certification from manufacturer that products furnished are appropriate for surfaces and conditions to which they will be applied.
      c. Certify that applicator is approved by manufacturer.
   2. Field Quality Control Submittals:
      a. Results of tests on job mock-ups.
      b. Pre-construction and post-construction field test reports.
      c. Compatibility and adhesion test reports.
      d. Contractor's Field Test Report Logs:

1) Indicate time present at the Site.
2) Include observations and results of field tests, and document compliance with manufacturer's installation instructions and supplemental instructions provided to installers.

3. Pre-installation conference record.
4. Qualifications: Submit qualifications for:
   a. Installer.
   b. Testing laboratory (if not already submitted under Section 01 4523, Testing Laboratory Services Furnished by Owner, or Section 01 4513, Testing Laboratory Services Furnished by Contractor).

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
   a. Recommended inspection intervals.
   b. Instructions for repairing and replacing failed sealant joints.
2. Warranty: Submit written warranties as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 6500, Product Delivery Requirements, and Section 01 6600, Product Storage and Handling Requirements, and the following:
1. Delivery of Products:
   a. Deliver products in calking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
   b. Include the following information on label:
      1) Name of material and Supplier.
      2) Formula or Specification Section number, lot number, color and date of manufacture.
      3) Mixing instructions, shelf life, and curing time, when applicable.
2. Storage of Products:
   a. Do not store or expose materials to temperature above 90 degrees F or store in direct sunlight.
   b. Do not use materials that are outdated as indicated by shelf life.
   c. Store sealant tape in manner that will not deform tape.
   d. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 75 degrees F.
   e. When high temperatures prevail, store mixed sealants in a cool place.
3. Handling:
   a. not open containers or mix components until necessary preparatory Work and priming are complete.

1.6 JOB CONDITIONS

A. Environmental Conditions:
1. Do not install joint sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
2. Proceed with the Work when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installa-

tion temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.

4. When high temperatures prevail, avoid mixing sealants in direct sunlight.
5. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
6. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.
7. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas of calking, sealants, and painting Work, and areas where Owner's personnel or construction personnel may work. Properly locate and vent such heat sources to outdoors so that joint sealants and other Work are unaffected by exhaust.

1.7 WARRANTY

A. Provide written warranty, signed by manufacturer and Contractor, agreeing to repair or replace sealants that fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in approved Shop Drawings and other submittals, as an inherent quality of material for exposure indicated.

1. Provide manufacturer warranty for period of one year from date of Substantial Completion of joint sealants Work.
2. Provide installer warranty for period of two years from date of Substantial Completion of joint sealants Work.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. VOC Performance Criteria:

1. VOC content of sealants used shall comply with current VOC content limits of SCAQMD Rule 1168. Sealants used as fillers shall comply with or exceed requirements of BAAQMD Regulation 8, Rule 51.
    a. Sealants: 250 g/L.
    b. Sealant Primers for Nonporous Substrates: 250 g/L.
    c. Sealant Primers for Porous Substrates: 775 g/L.

C. Provide colors selected by Engineer from calking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide same generic products and colors as available from manufacturers specified.

2.2 MATERIALS

A. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Potable Water or Water That Will be Treated to Become Potable:

1. One-component Polyurethane Sealant:

a. Products and Manufacturers: Provide one of the following:
   1) Sikaflex-1a by Sika Corporation.
   2) Or equal.
b. One-component, moisture cured, gun grade, polyurethane sealant, complying with:
   1) FS TT-S-00230C, Type II, Class A; ASTM C920, Type S, Grade NS, Class 25.
   2) Adhesion-in-Peel, FS TT-S-00230C, ASTM C794 (minimum five pounds.): Glass, minimum 20 pounds per linear inch; Aluminum, minimum 20 pounds per linear inch; Concrete, minimum 20 pounds per linear inch.
   3) Hardness (Standard Conditions), ASTM D2240: 20 to 25 (Shore A).
   4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
   5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
   6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
   7) VOC Content: 100 g/L, maximum.
   8) Listed in NSF/ANSI 61

2. Two-component Polyurethane Sealant:
   a. Products and Manufacturers: Provide one of the following:
      1) Sikaflex- 2c NS by Sika Corporation.
      2) Or equal.
   b. Two-component, moisture cured, gun grade, polyurethane sealant, complying with:
      1) FS TT-S-00227E, Type II, Class A; ASTM C920, Type M, Grade NS, Class 25.
      2) Adhesion-in-Peel, FS TT-S-00227E, ASTM C794 (Minimum five pounds per linear inch with no adhesion failure): 18 pounds.
      3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
      4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
      5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
      6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
      7) Content: 220 g/L, maximum.
      8) in NSF/ANSI 61

B. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Wastewater:

2.3 TWO-COMPONENT POLYURETHANE SEALANT:

A. Products and Manufacturers: Provide one of the following:
   1. Sikaflex- 2c NS by Sika Corporation.
   2. Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
   3. Or equal.

B. Polyurethane based, two-component elastomeric sealant complying with:
   1. FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.

2. Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 18 lbs.
3. Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
4. Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
5. Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
6. Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
7. Content: 220 grams per liter, maximum.

C. Exterior and Interior Vertical Joints; Non-submerged:
1. Two-component Polyurethane Sealant:
a. Products and Manufacturers: Provide one of the following:
1) Sikaflex- 2c NS by Sika Corporation.
2) Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.
3) Or equal.
b. Polyurethane based, two-component elastomeric sealant complying with:
1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 10 pounds.
3) Hardness (Standard Conditions), ASTM C661: 25 to 35 (Shore A).
4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
7) Content: 100 g/L, maximum.

D. Exterior and Interior Horizontal Joints; Non-submerged:
1. Two-component Polyurethane Sealant:
a. Products and Manufacturers: Provide one of the following:
1) Sikaflex- 2c SL by Sika Corporation.
2) THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
3) Or equal.
b. Polyurethane based, two-component elastomeric, self-leveling sealant complying with the following:
1) FS TT-S-00227E, Type I (self-leveling) Class A. and ASTM C920, Type M, Grade P, Class 25
2) Water Immersion Bond, FS TT-S-00227E: Elongation of 50 percent with no adhesive failure.
3) Hardness (Standard Conditions), ASTM C661: 35 to 45.
4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
6) Content: 165 g/L, maximum.

E. Miscellaneous Materials:
   1. Joint Cleaner: As recommended by calking and sealant manufacturer.
   2. Joint Primer and Sealer: As recommended for compatibility with calking and sealant by calking and sealant manufacturer.
   3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended for compatibility with calking and sealant by calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape where applicable.
   4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by calking and sealant manufacturer. Provide size and shape of rod that will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide highly-compressible backer to minimize possibility of sealant extrusion when joint is compressed.
   5. Low-temperature Catalyst: As recommended by calking and sealant manufacturer.

F. Products for Other Applications:
   1. Glazing Sealants: Refer to Section 08 8100, Glass Glazing.
   2. Fire-Rated Sealants: Refer to Section 07 2105, Building Insulation.
   3. Compressible Filler: Refer to Section 04 0511, Masonry Anchorage and Reinforcing.
   4. Acoustical Sealants: Refer to Section 09 5113, Acoustical Panel Ceilings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which calking and sealant Work will be performed, and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work and performance of sealants. Do not proceed with calking and sealant Work until unsatisfactory conditions are corrected.

B. Laboratory Pre-construction Compatibility and Adhesion Testing: Submit to joint sealant manufacturers for testing indicated below samples of materials that will contact or affect joint sealants.
   1. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit at least eight pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For products that fail tests, obtain joint-sealant manufacturer's written instructions for corrective measures including using specially formulated primers.
   5. Immersion Testing: ASTM C1247 for potable water and wastewater.
   6. Testing will not be required if joint sealant manufacturers submit joint preparation data based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted and mock-up field testing is acceptable.

3.2 PREPARATION

A. Protection: Do not allow joint sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or calking and sealant materials.

B. Joint Surface Preparation:
   1. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
   2. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.
   3. Roughen joint surfaces on vitreous coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
   4. Concrete Joint Preparation: Refer to Section 03 1500, Concrete Accessories

C. Mixing:
   1. Comply with sealant manufacturer's written instructions for mixing multi-component sealants.
   2. Thoroughly mix components before use.
   3. Add entire contents of activator can to base container. Do not mix partial units.
   4. Mix contents for minimum of five minutes or as recommended by sealant manufacturer, until color and consistency are uniform.

3.3 INSTALLATION

A. Install joint sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure calking and sealant joints will not be soiled. Replace calking and sealant joints soiled after installation.

B. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents, and except where manufacturer's technical representative directs otherwise, only as acceptable to Engineer.

C. Prime or seal joint surfaces as shown on approved Shop Drawings and approved other submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.

D. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

E. Confirm that compressible filler is installed before installing sealants. Refer to Section 04 0505, Unit Masonry Construction, for locations.

F. Do not install sealants without backer rods and bond breaker tape.

G. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.

H. Employ only proven installation techniques that will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

I. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
   1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
   2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.

J. Remove excess and spillage of compounds promptly as the Work progresses.

K. Cure calking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.

3.4 EXISTING JOINTS

A. Mechanically remove existing sealant and backer rod.

B. Clean joint surfaces of residual sealant and other contaminates capable of affecting sealant bond to joint surface.

C. Conduct laboratory pre-construction compatibility and adhesion testing on joint surfaces in accordance with Paragraph 3.1.B of this Section.

D. Allow joint surfaces to dry before installing new sealants.

3.5 FIELD QUALITY CONTROL

A. Post-construction Field Adhesion Testing: Before installing elastomeric sealants, field-test joint sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed elastomeric sealant joints as follows:
      a. Perform ten tests for the first 1,000 feet of joint length for each type of elastomeric sealant and joint substrate.
      b. Perform one test for each 1,000 feet of joint length thereafter, and minimum of one test per each floor per elevation.
      c. Test Method: Test joint sealants according to Method A, Field-applied Sealant Joint Hand Pull Tab, and Method D, Water Immersion in Appendix X1 of ASTM C1193. For joints with dissimilar substrates, verify adhesion to each substrate separately by extending cut along one side and verifying adhesion to opposite side. Repeat procedure for opposite side.
      d. Inspect joints for complete fill, absence of voids, and joint configuration complying with specified requirements. Record results in a log of field adhesion tests.

e. Inspect tested joints and report on whether:
   1) Sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
   2) Sealants filled the joint cavities and are free of voids.
   3) Sealant dimensions and configurations comply with specified requirements.

f. Record test results in a log of field adhesion tests. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

g. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

h. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other requirements will be satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

i. Do not proceed with installation of elastomeric sealants over joint surfaces that have been painted, lacquered, waterproofed, or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

B. Water Leak Testing: Field test for water leaks as follows:
   1. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, two feet from joint and connected to water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
   2. Test approximately five percent of total joint system, in locations that are typical of every joint condition, and that can be inspected easily for leakage on opposite face. Conduct test in presence of Engineer, who will determine actual percentage of joints to be tested and actual period of exposure to water from hose, based on extent of observed leakage or lack of observed leakage.
   3. Where nature of observed leaks indicates potential of inadequate joint bond strength, Engineer may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion.

3.6 ADJUSTING AND CLEANING

A. Where leaks and lack of adhesion are evident, replace sealant.

B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish Work in neat, clean condition.

C. Protect sealants during construction so that they will be without deterioration, soiling, or damage at time of readiness for final payment of the Contract.

3.7 PROTECTION

A. During and after curing period, protect joint sealants from contact with contaminating substances and from damage resulting from construction operations or other causes, so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original Work.

END OF SECTION 07 9200

SECTION 08 1113

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install hollow metal doors and frames.
   2. Extent of hollow metal doors and frames is shown.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the hollow metal doors and frames Work.

C. Related Sections:
   1. Section 04 0505, Unit Masonry Construction.
   2. Section 06 1053, Miscellaneous Rough Carpentry.
   3. Section 07 9200, Joint Sealants.
   4. Section 08 7100, Door Hardware.
   5. Section 08 8100, Glass Glazing.
   6. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
      a. ANSI in association with Steel Door Institute, ANSI/SDI 100, Steel Doors and Frames.
      b. ANSI in association with Door and Hardware Institute, ANSI/A115.1-A115.17/DHI, Specifications for Steel Door and Frame Preparation for Hardware.
      c. ANSI A224.1, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
      d. ANSI A250.3, Test Procedure and Acceptance Criteria for Factory-Applied Finish Painted Steel Surfaces for Steel Doors and Frames.
      e. ANSI A250.4, Test Procedures and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings.
      f. ANSI A250.5, Accelerated Physical Endurance Test Procedure for Steel Doors, Frames, and Frame Anchors.
      g. ANSI/NFPA 252, Fire Tests of Door Assemblies.
   2. American Society for Testing and Materials, (ASTM).
      a. ASTM A 153/A 153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. ASTM A 366, Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
      c. ASTM A 653/A 653M, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by The Hot-Dip Process.
      d. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.

e. ASTM E 1408, Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems.

3. Door and Hardware Institute, (DHI).
   a. DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
4. National Fire Protection Association, (NFPA).
   a. NFPA 80, Fire Doors and Fire Windows.
5. Steel Door Institute, (SDI/Door).
   a. SDI/Door 105, Erection Instructions for Steel Frames.
   b. SDI/Door 106, Standard Door Type Nomenclature.
   c. SDI/Door 112, Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames.
   d. SDI/Door 117, Manufacturing Tolerances Standard Steel Doors and Frames.
   e. SDI/Door 122, Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
   f. SDI/Door 128, Guidelines for Acoustical Performance of Standard Steel Doors and Frames.
6. The Society for Protective Coatings, (SSPC).
   a. SSPC Paint 2, Cold Phosphate Surface Treatment.
   b. SSPC Paint 27, Basic Zinc Chromate-Vinyl Butyral Wash Primer.
7. Underwriters' Laboratories Inc., (UL).
   a. UL 10B, Fire Tests of Door Assemblies.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Provide hollow metal doors, frames, and accessories manufactured by a single firm specializing in the production of this type of Work and complying with specified standards of ANSI, NFPA, SDI and UL.
   3. Provide hollow metal doors and frames from a manufacturer who is a member of SDI.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single hollow metal doors and frames manufacturer.
   2. The hollow metal doors and frames equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the hollow metal doors and frames manufacturer.

C. Regulatory Requirements:
   1. Fire-Resistance-Rated Assemblies: Wherever a fire-resistance classification is shown or scheduled for hollow metal doors and frames (3-hour, 1-1/2-hour, and similar designations), provide fire-resistance-rated hollow metal doors and frames tested as a fire door assembly, complete with type of fire door hardware to be used.
   2. Identify each fire-resistance-rated door and frame with recognized testing laboratory labels, indicating applicable fire-resistance-rating of both door and frame. Provide fire-resistance-

rated doors and frames with metal labels permanently fastened to door and frame. Labels shall display all UL required information.

3. Temperature Rise Rating: Wherever a temperature rise rating is required by the building code, provide doors for fire-resistance-ratings shown and in accordance with UL 10B.
    a. For a UL 3-hour (A) classification, provide doors with a temperature rise rating of not more than 250°F maximum to 30 minutes of exposure.
    b. For a UL 1-1/2-hour (B) classification, provide doors with a temperature rise rating of not more than 450°F or 650°F maximum to 30 minutes of exposure.
4. Door and frame assemblies shall comply with NFPA 80, and as specified. Modify specified hollow metal door and frame system components to comply with requirements of governing jurisdictions for fire-resistance-rated construction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. Fabrication and installation drawings of hollow metal doors and frames. Include details of each frame type, elevations of each door type, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints, connections and every composite member. Show all door and frame reinforcements, including welds, plate lengths, locations and gauges, identified for each component of finish hardware specified in Section 08 7100, Door Hardware.
        b. Provide a schedule of doors and frames using same reference numbers for details and openings as those shown.
    2. Samples:
        a. Pressed metal corner section of frame, 12-inches by 12-inches minimum, showing all special, supplemental and standard reinforcements, attachments, supports and anchors specified. Provide corner sample for each type of frame specified.
        b. Cut-away section of all door types specified, showing internal construction, edge details and reinforcements for butts, closers and similar items of finished hardware, 2 foot-0 inches by 2 foot-0 inches minimum. Include louver sections, vision panel and glazing stops.
        c. Engineer reserves the right to require samples showing fabrication techniques and workmanships of all component parts, and the detailing and fabrication of accessories and auxiliary items for all door and frame Work, before fabrication of the Work proceeds.

B. Informational Submittals: Submit the following:
    1. Certificates:
        a. Certification of Labeled Construction for fire-resistance-rated doors and frames.
    2. Test and Evaluation Reports:
        a. Laboratory test report for required performance and specified feature verification for doors and frames selected at random by Engineer for testing.
        b. Test reports indicating compliance with ANSI A250.4 and ANSI A250.5.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
2. Deliver hollow metal doors and frames cartoned or crated to provide protection during transit and job storage.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store doors and frames at the Site under cover.
3. Place units up off floors in a manner that will prevent rust and damage.
4. Avoid the use of non-vented plastic or canvas shelters, which could create a humidity chamber. If cardboard wrapper on the door becomes wet, remove the carton immediately.
5. Provide a 1/4-inch space between stacked doors to promote air circulation.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
1. Door Classification: Provide hollow metal doors of Grades and Models in accordance with ANSI/SDI 100, and ANSI A250.5 as follows:
a. Grade III, Extra Heavy-Duty, 1-3/4-inches thick (Level A); Model 2A, seamless design.

B. Details of Construction:
1. Provide doors of two outer stretcher-leveled sheets, 16-gauge minimum. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or edges, except around glazed or louvered panel inserts. No fillers shall be used. Provide weep hole openings in the bottom of exterior doors to permit the escape of entrapped moisture.
2. Reinforce inside of doors with honeycomb core completely filling the inside of the door and laminated to the inside of both face panels with an adhesive. The honeycomb material shall have a crushing strength not less than 6,000 pounds per square foot and the lamination shall withstand not less than 1,100 pounds per square foot in shear.

C. Frame Construction:
1. Form frames of cold-rolled sheet material, 16-gauge minimum. Provide seamless frames for all Work, unless specifically specified and shown as permitting exposed fasteners.
2. Provide hollow metal frames for doors, transoms, side-lights, borrowed lights, and other openings of size and profile as shown or specified.

2.2 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:

1. Series CH with DURA-WELD seams with Series F16 Frames and DW F16 Frames by Pioneer Industries, Incorporated.
2. Or equal.

2.3 MATERIALS

A. Door Faces and Frames: Zinc-coated, cold-rolled carbon steel sheets of commercial quality, complying with ASTM A 366, and ASTM A 653/A 653M, G 60 zinc coating, mill-phosphatized.

B. Honeycomb Core: Phenolic resin-impregnated, nominal 1-inch hexagonal cell size, one piece, Kraft fiber core board, with 42 psi minimum crushing strength.

C. Supports and Anchors: Formed sheet metal, hot-dip galvanized after fabrication complying with ASTM A 153/A 153M, Class B, and in compliance with requirements of ANSI A250.5. Provide supports and anchors as follows:
   1. Jamb Anchors: 16-gauge minimum, and of the following types:
      a. Masonry Construction: Adjustable, corrugated or perforated, T-shaped to suit frame size with leg not less than 2-inches wide by 10-inches long.
      b. Gypsum Wallboard and Steel Stud Construction: Two-piece compression anchors with exposed compression fasteners.
   2. Floor and Head Anchors: 14-gauge minimum, and of the following types:
      a. Monolithic Concrete Slabs: Clip-type, with two holes to receive fasteners, welded to bottom of jambs and mullions.
      b. Separate Topping Concrete Slabs: Adjustable-type with extension clips, allowing not less than 2-inches height adjustment. Terminate bottom of frames at finish floor surface.

D. Inserts, Bolts and Fasteners: Sheet metal hot-dip galvanized complying with ASTM A 153/A 153M, Class C or D as applicable.

E. Miscellaneous Accessories:
   1. Head Strut Supports: 3/8-inch by 2-inch hot-dipped galvanized steel.
   2. Structural Reinforcing Members: Provide structural reinforcing members as part of frame assembly, where shown at mullions, transoms, or other locations that are to be built into frame.
   3. Head Reinforcing: For frames over 4 feet-0 inch wide, in masonry openings, provide continuous steel channel or angle stiffener, not less than 12-gauge for full width of opening, welded to back of frame at head.
   4. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
   5. Plaster Guards: 26-gauge minimum galvanized steel.
   6. Louvers, Stops and Moldings: 16-gauge minimum, cold-rolled, hot-dipped galvanized, formed sheet metal.

2.4 FABRICATION

A. General:
   1. Fabricate hollow metal units to be rigid, neat in appearance and free for defects, warp or buckle. Accurately form metal to required sizes and profiles.
   2. Wherever practicable, fit and assemble units in the manufacturer's plant. Clearly identify Work that cannot be permanently factory-assembled before shipment, to assure proper

assembly at the Site. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible. Filler to conceal manufacturing defects shall not be acceptable.

3. Exposed Fasteners: Unless otherwise shown or specified, do not use exposed fasteners in the Work. Where exposed fasteners are shown or specified, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.

B. Doors:
   1. Fabricate all hollow metal doors and panels in compliance with ANSI A250.5.
   2. Fabricate all doors with flush top and bottom closing channel, without exposed fasteners. Reinforce tops and bottoms of doors with inverted, flush-mounted, minimum 20-gauge, horizontal steel channels fastened to internal reinforcement channel and with 20-gauge closing plate spot-welded to closure channel. Close top and bottom edges to provide weather seal, as integral part of door construction or by addition of inverted steel channels and plates.
   3. Hollow Metal Panels:
      a. Fabricate hollow metal panels of the same materials, construction, and finish as specified for hollow metal doors.
      b. Provide astragal integral with top of door where shown.
   4. Edge profiles shall be provided on both stiles of doors beveled 1/8-inch in 2-inches.

C. Frame Construction:
   1. Fabricate all hollow metal frames in compliance with ANSI A250.5 and as specified.
   2. Fabricate frames with reinforced, mitered corners that are continuously arc-welded for the full depth and width of the frame, with bottom spreader bar; except provide drywall frames as specified.
   3. Grind all exposed welds flush and smooth.
   4. Knock-down-type frames shall be used for drywall construction only and shall provide the following additional features:
      a. Specifically designed for drywall construction.
      b. Frames shall be knocked down, designed to be securely installed in the rough opening after the wallboard is applied.
      c. Jamb and head connection shall be a neat, flush, miter with head securely locked to top of jamb.
      d. Mitered corners shall be reinforced with a concealed corner cup to provide a firm interlock of jamb to head.
      e. Provide two anchors at head of frames exceeding 3 foot-6 inches wide.
      f. Provide vertical steel head support struts extending from top of frame at each jamb to supporting construction above. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
   5. Mullions and Transom Bars:
      a. Provide closed mullions and transom bars where shown. Fasten mullions and transom bars at crossings and to jambs by butt-welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.
   6. Head Reinforcing: Where installed in masonry, leave vertical mullions in frames open at the top so they can be filled with grout.
   7. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
   8. Head Anchors: Provide two anchors at head of frames exceeding 3 foot-6 inches wide for frames mounted in drywall partitions.

9. Head Strut Supports: Provide vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
10. Rubber Door Silencers: Drill stop to receive three silencers on single-door frames and four silencers on double-door frames. Install plastic plugs to keep holes clear during construction.
11. Plaster Guards: Provide manufacturer's standard plaster guards or dust cover boxes.

D. Finish Hardware Preparation:
1. General:
   a. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with approved Finish Hardware Schedule and templates provided by finish hardware supplier and as specified. Comply with applicable requirements of ANSI/DHI A115.1 to A115.17 and ANSI A250.4. Refer to Section 08 7100, Door Hardware.
   b. Obtain approved hardware schedule, hardware templates, and samples of finish hardware where necessary to ensure correct detailing and fabrication of the hollow metal doors and frames, from finish hardware supplier.
2. Doors:
   a. Preparation includes sinkages, and cut-outs for mortised and concealed finish hardware and reinforcements for both concealed and surface-applied finish hardware.
   b. Drill and tap mortise reinforcements at factory, using templates.
   c. Detail and fabricate reinforcements with concealed connections designed to develop full strength of reinforcements for high-frequency applications.
   d. Reinforce doors for required finish hardware, with minimum gauges of reinforcements provided as follows:
      1) Hinges: Steel plate 3/16-inches thick by 1-1/2-inches wide by 6-inches longer than hinge and secured by not less than six spot or projection welds with top hinge further reinforced with a high-frequency back-up reinforcement.
      2) Mortise Locksets and Dead Bolts: 12-gauge steel sheet, secured with not less than four spot or projection welds.
      3) Cylinder Locks: 12-gauge steel sheet, secured with not less than two spot or projection welds.
      4) Flush Bolts: 12-gauge steel sheet, secured with not less than two spot or projection welds.
      5) Surface-Applied Closers and Overhead Stops: 3/16-inch steel plate, not less than 10-inches long, secured with not less than six spot or projection welds.
      6) Push Plates and Bars: 16-gauge steel sheet secured with not less than two spot or projection welds.
      7) Surface Panic Devices: 16-gauge sheet steel secured with not less than two spot or projection welds.
      8) Automatic Door Bottoms: Reinforce for mortise-type units with 14-gauge steel, and 16-gauge for surface-applied units.
3. Frames:
   a. Reinforce frames for required finish hardware with minimum gauges as follows:
      1) Hinges and Pivots: Special full width of frame, 3/16-inch thick steel plate by 8-inches longer than hinge, secured to both rabbets by not less than twelve spot or projection welds.

2) Strike Plate Clips: 10-gauge steel plate by 1-1/2-inches wide by 3-inches long with mortar guard boxout secured with not less than six spot or projection welds.
3) Surface-Applied Closers: 3/16-inch steel plate, secured with not less than six spot or projection welds. Coordinate closer function and presence of overhead stops and weather-stripping, with location of reinforcement plate.
4) Concealed Closers: Removable steel access plate, 12-gauge internal reinforcement of size and shape required, and enclosing housing to keep closer pocket free of mortar or other materials.

E. Stops and Moldings:
1. Provide stops and moldings around solid, glazed and louvered panels in hollow metal units and in frames to receive glass.
2. Fabricate fixed stops and moldings integral with frame. Provide fixed stops on inside of hollow metal units exposed to exterior and on corridor side of interior units.
3. Provide removable stops and molds at other locations, formed of not less than galvanized 20-gauge steel sheets. Secure with countersunk machine screws spaced uniformly not more than 12-inches on center. Form corners with butted hairline joints.
4. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated. Refer to Section 08 8100, Glass Glazing.

2.5 SHOP PAINTING

A. Clean, treat and paint exposed surfaces of fabricated hollow metal units, including galvanized surfaces.

B. Clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before the application of the shop coat of paint.

C. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC Paint 2), or basic zinc chromate-vinyl butyral solution (SSPC Paint 27).

D. Refer to Section 09 9100, Painting, for field-applied primer and finish paint for exterior or interior exposed ferrous, non-ferrous, or galvanized surfaces.

E. Apply shop-coat of prime paint within time limits recommended by pretreatment manufacturer. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 1.5-mils.

F. Finish shall be rust inhibitive primer capable of passing a 500-hour salt spray and a 1,000-hour humidity test in accordance with ASTM B 117 as certified by an independent laboratory.

2.6 SOURCE QUALITY CONTROL

A. After Shop Drawings approval, manufacturer shall not make any further detailing, fabrication or changes to approved methods of support and anchorage, nor shall doors and frames be brought to the Site, which do not conform, in all ways, to performance criteria specified.

B. Allowable Tolerances: Provide door and frame manufacturing tolerances in compliance with SDI 117 and as follows:
1. Nominal Clearance between Door and Frame Head and Jamb: 1/8-inch.

2. Nominal Clearance between Meeting Edges of Pairs of Doors: 1/8-inch.
3. Nominal Clearance at Bottom of Door: 3/4-inch.
4. Nominal Clearance between Face of Door and Door Stop: 1/16-inch.
5. Provide all Work plumb and true to adjoining surfaces with all miters and copes accurately formed.
6. Provide completely water and vapor tight joints.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the substrate and conditions under which hollow metal doors and frames are to be installed and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Frames that are bowed, twisted or otherwise unacceptable shall be removed from the Site and replaced with properly constructed frames.

3.2 PREPARATION

A. Drilling and tapping for surface-applied, finish hardware may be done at Site.

B. Protective Coating: Protect inside, concealed, faces of door frames in plaster or masonry construction using fibered asphalt emulsion coating. Apply over shop primer approximately 1/8-inches thick and allow to dry before installation.

3.3 INSTALLATION

A. Install hollow metal units and accessories in accordance with approved Shop Drawings, SDI 105 and as shown and specified.
1. Do not install doors and frames until all the Work, which could damage doors and frames, has been completed.
2. Provide temporary doors until construction sequencing allows installation of permanent doors and frames.
3. Do not proceed with the installation of permanent hollow metal doors until Contractor can provide finished Work complying with all requirements of these Specifications.
4. Protect built-in frame Work with temporary wood protection.

B. Placing Frames:
1. Place frames at fire-rated openings in accordance with NFPA 80.
2. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Remove spreader bars only after frames have been properly set and secured.
3. Make field splices in frames as detailed on approved Shop Drawings, welded and finished to match factory work.

C. Setting Masonry Anchorage Devices:
1. In masonry construction, building in of anchors and grouting of frames is included in Section 04 0505, Unit Masonry Construction.

2. Set anchorage devices opposite each anchor location, in accordance with details on approved Shop Drawings and anchorage device manufacturer's instructions as follows:
    a. Masonry Walls: Install at least three jamb anchors per jamb up to 7 feet-6 inches height; four anchors up to 8 feet-0 inch jamb height; one additional anchor for each 2 foot-0 inch or fraction thereof over 8 feet-0 inch height.
    b. Structural Steel: Secure frames to structural steel framing using machine bolts inserted through tubular steel pipe sleeves reinforcement concealed in hollow metal frames at 6-inches from top and bottom and 2 foot-0 inches on center. Apply removable stop to cover anchor bolts.
    c. Steel Stud Construction: Secure knocked-down-type drywall frames to gypsum wallboard metal studs using compression anchor assemblies. Install at least three jamb anchors per jamb up to 7 feet-6 inches height; four anchors up to 8 feet-0 inch jamb height; one additional anchor for each 2 foot-0 inch or fraction thereof over 8 feet-0 inch height.
3. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on approved Shop Drawings.

D. Door Installation:
1. Fit hollow metal doors accurately in their respective frames, with the following clearances:
    a. Jambs and Head: 3/32-inch.
    b. Meeting Edges, Pairs of Doors: 1/8-inch.
    c. Bottom: 3/4-inch, where no threshold.
    d. Bottom: At threshold, 1/8-inch.
2. Place fire-resistance-rated doors with clearances as specified in NFPA 80.
3. Finish hardware installation is specified under Section 08 7100, Door Hardware. Locate finish hardware as shown on approved Shop Drawings, in accordance with hardware templates provided by finish hardware manufacturers and in accordance with Door and Hardware Institute, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.

3.4 ADJUSTMENT AND CLEANING

A. Check and readjust operating finish hardware items in hollow metal door and frame Work just prior to final inspection. Leave Work in complete and proper operating conditions.

B. Where problems of installation or damage are cause for rejection of hollow metal door and frame Work, consult SDI 122 and the recommendations of the hollow metal door and frame manufacturer, for suggestions concerning required adjustments in the Work. Submit recommendations to Engineer for approval. Replace and repair unacceptable Work, as directed by Engineer, so that there will be no doubt as to the acceptability of the Work at the time of Substantial Completion.

C. Prime Coat Touch-Up: Immediately after installation, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

D. Protection: Protect installed hollow metal doors and frames against damage from other construction activities.

END OF SECTION 08 1113

SECTION 08 1116

ALUMINUM DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all aluminum doors and frames Work.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the aluminum doors and frames Work.

C. Related Sections:
   1. Section 04 0505, Unit Masonry Construction.
   2. Section 06 1053, Miscellaneous Rough Carpentry.
   3. Section 07 9200, Joint Sealants.
   4. Section 08 7100, Door Hardware.
   5. Section 08 8100, Glass Glazing.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. Aluminum Association, (AA).
      a. AA DAF 45, Designation System for Aluminum Finishes.
   2. Architectural Aluminum Manufacturing Association, (AAMA).
      a. AAMA 701.1, Standard for Sliding Weatherstripping.
   3. American Society for Testing and Materials, (ASTM).
      a. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
      b. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
      c. ASTM D 523, Test Method for Specular Gloss.
      d. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
      e. ASTM D 1308, Practice for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
      f. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
      g. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
      h. ASTM D 4214, Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
   4. National Association of Architectural Metal Manufacturers, (NAAMM).
      a. NAAMM, Hardware Location for Custom Hollow Metal Doors.
      b. NAAMM, Metal Finishes Manual.
   5. The Society for Protective Coatings, (SSPC).
      a. SSPC Paint 12, Cold Applied Asphalt Mastic (Extra Thick Film).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Provide aluminum doors, transom and frames manufactured by a single firm specializing in the production of this type of Work. Manufacturer shall have a minimum of five years of experience in the production of aluminum doors and frames, and shall be able to show evidence of satisfactory operation in at least five installations.

B. Component Supply and Compatibility:
   1. Obtain all products included in this Section regardless of the component manufacturer from a single aluminum doors and frames manufacturer.
   2. The aluminum doors and frames manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the aluminum doors and frames manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Copies of manufacturer's fabrication and installation drawings of aluminum doors and frames. Include details of each frame type, elevations of each door type, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, details of joints and connections. Show all door and frame reinforcements.
      b. Provide a schedule of doors and frames using same reference numbers for details and openings as those shown.
   2. Samples: Submit the following:
      a. Samples of each required aluminum finish, on 12-inch long extrusions or 6-inch square sheets, of the alloys to be used for the Work. Where normal color and texture variations are to be expected, include two or more units in each sample, to show the range of such variations.
      b. Samples shall be reviewed by Engineer for color and texture only. Compliance with other requirements is the exclusive responsibility of Contractor.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
   2. Deliver aluminum doors and frames cartoned or crated to provide protection during transit and job storage.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store doors and frames at the Site under cover. Place units up off the floors in a manner that will prevent corrosion and damage. Avoid the use of non-vented plastic or canvas

shelters, which could create a humidity chamber. If the cardboard wrapper on the door becomes wet, remove the carton immediately. Provide a 1/4-inch space between stacked doors to promote air circulation.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: Provide aluminum Alloy 6063-T5 or equal for properties of strength (not less than 22,000 pounds per square inch ultimate tensile strength), corrosion resistance, abrasion resistance, application of required finish, and control of color.

B. Aluminum Sheets:
1. Provide aluminum Alloy 5005-H14, or equal, for properties of strength corrosion resistance, abrasion resistance, application of required finish, and control of color.
2. Provide smooth sheet for exposed faces of doors and panels, except as otherwise specified.

C. Fasteners: Aluminum, non-magnetic stainless steel or other non-corrosive metal fasteners guaranteed by the manufacturer to be compatible with the doors, frames, stops, panels, hardware, anchors and other items being fastened.
1. For exposed fasteners (if any), provide Phillips flat-head screws with finish matching the item fastened.
2. Do not use exposed fasteners, except where unavoidable for the assembly of units, and unavoidable for the application of hardware. Provide only concealed screws in glazing stops.

D. Reinforcement and Brackets: Manufacturer’s standard formed or fabricated aluminum units, of shapes, plates or bars.

E. Inserts: For required anchorage into concrete or masonry work, furnish inserts of 12- gauge steel stainless steel after fabrication.

F. Expansion Anchor Devices: Stainless steel, drilled-in, expansion bolt anchors.

G. Bituminous Coatings: Cold-applied asphalt mastic complying with SSPC Paint 12, compounded for 30-mil thickness per coat.

2.2 FABRICATION

A. General:
1. Sizes and Profiles: The required sizes for door and frame units and the profile requirements are shown. Variable dimensions for profiles (if any) are shown along with maximum and minimum dimensions as required to achieve design requirements and coordination with other work.

2. The details shown are based upon standard details by one or more manufacturers. Similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/maximum profile requirements as shown.

B. Flush Type Aluminum Doors:
1. Provide tubular frames members with minimum wall thickness of 1/8-inch, fabricated with reinforced mechanical or welded joints in accordance with manufacturer's standard fabrication methods. Limit edge exposure and face molding exposure to 0.50-inch maximum width.
2. Fabricate flush doors with cores laminated between two sheets of 0.040-inch thick aluminum laminated to 1/8-inch thick oil-tempered hardboard with epoxy adhesive to form a door thickness of 1-3/4-inch and of a true 5-ply construction.
3. Provide cores of 20 percent phenolic resin-impregnated honeycomb material 80 lbs. per 3,000 sq. ft. ream, (7/16-inch cells) laminated with an epoxy adhesive between two sheets of 1/8-inch thick tempered hardboard.
4. Provide transom frames of the same material, finish, thickness and gauge as the door and frame material.
5. Products and Manufacturers: Provide one of the following:
   a. 100 BE Doors with Frame by Cline Aluminum Doors, Inc.
   b. Or equal.

2.3 HARDWARE

A. Flush Doors: Refer to Section 08 7100, Door Hardware, and to the frame, door and hardware schedules and details, for the furnishing and installing of hardware items. Hardware templates only will be furnished to the manufacturer for the fabrication of door and frames to receive hardware not supplied by door manufacturer.

B. Hardware Installation: Cut, reinforce, drill and tap frames and doors as required to receive hardware, except do not drill and tap for surface-mounted items until the time of installation. Comply with hardware manufacturer's instructions and template requirements. Use concealed fasteners, wherever possible.

2.4 ALUMINUM FINISHES

A. General:
1. Preparation: After fabrication of doors and frames, but before lamination of panels, prepare the aluminum surfaces for finishing in accordance with the aluminum producer's recommendations and standards of the finisher or processor. Process all components of each assembly simultaneously to attain complete uniformity of color.
2. Samples:
   a. Comply with industry standard colors and texture samples. Establish Samples of the required finish, for Engineer'S acceptance, prior to fabrication of the Work. Engineer reserves the right to reject material finishes with objectionable variations from the established samples.
   b. Prepare samples on extrusions and sheets of the exact alloys to be used for the Work, and show range of natural variations to be expected in finished Work, by duplicate samples of varying color and texture.

B. Anodized Finishes: NAAMM AA-M10-C22-A41, (minimum thickness of 0.7- mils), Clear.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the substrate and conditions under which aluminum doors and frames Work are to be installed and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. Comply with manufacturer's specifications and recommendations for the installation of aluminum doors and frames.

B. Set units plumb, level and true to line, without warp or rack of frames, doors or panels. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 ADJUSTMENT AND CLEANING

A. Clean aluminum surfaces promptly after installation of frames and doors. Remove excess glazing and sealant compounds, dirt and other substances.

B. Where protective coating has been supplied, remove coating completely as soon as the completion of construction activities no longer requires its retention.

C. Contractor shall provide protective treatment and other precautions required as recommended by manufacturer, through the remainder of the construction period, to ensure that doors and frames will be without damage or deterioration (other than normal weathering) at the time of Final Acceptance.

END OF SECTION 08 1116

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SECTION 08 1613

FIBERGLASS REINFORCED PLASTIC DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install fiberglass reinforced plastic doors and frames as shown and specified.
   2. The extent of doors and frames Work is shown on the Drawings.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed or demolished in association with the doors and frames.

C. Related Sections:
   1. Section 07 92 00, Calking and Sealants.
   2. Section 08 71 00, Finish Hardware.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ANSI A115, Specifications for Door and Frame Preparations for Hardware.
   2. ASTM A 103, Zinc (hot-galvanized) Coatings on Products Fabricated From Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
   3. ASTM A 123, Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
   4. ASTM B 509, Cellular Elastomeric Preformed Gasket and Sealing Material.
   5. ASTM D 2000, Classification for Elastomeric Materials for Automotive Applications.
   6. Underwriters Laboratories, Inc. “Standard for Fire Test of Doors, UL10B”.
   7. ASTM D 635, Standard Test Method for Rate of Burning or Extent and Time of Burning of Self Supporting Plastics in a Horizontal Position.
   8. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   9. ASTM D 2287, Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
   10. NAAMM, Entrance Manual.
   11. Laminate properties:
      a. ASTM D 882 Tensile strength.
      b. ASTM D 790 Flexural strength.

c. ASTM D 2583 Barcol Hardness.
d. ASTM D 256 Impact resistance.
e. ASTM D 792 Density/specific gravity of laminate.

12. Core Properties
    a. ASTM C 177 Thermail properties.
    b. ASTM D 1622 Density/specific gravity.
    c. ASTM D E 84 Surface burning characteristics.

B. Manufacturer Qualifications: Provide doors and frames manufactured by a single firm specializing in the production of this type of Work.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Product Data: Manufacturer's printed product data indicating characteristics of products specified in this Section.
2. Plans: Indicate location of each door opening assembly in project.
3. Elevations: Dimensioned elevation of each type door opening assembly in project; indicate sizes and locations of door hardware, and lites and louvers, if specified.
4. Details: Installation details of each type installation condition in project; indicate installation details of glazing, if specified.
5. Schedule: Indicate each door opening assembly in project; cross-reference to plans, elevations, and details.

B. Selection Samples: Manufacturer's standard color chips.

C. Verification Samples: Two (2) samples to verify color match.

D. Manufacturer's Instructions: Printed installation instructions for door opening assemblies.

E. Warranty Documents: Manufacturer's standard warranty documents, executed by manufacturer's representative, countersigned by Contractor.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Package door opening assemblies in manufacturer's standard containers.

B. Storage of Materials:
1. Store door assemblies in manufacturer's standard containers, on end, to prevent damage to face corners and edges.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fiberglass Met: Random glass fiber mat. Minimum 4.5 ounces per square foot weight of glass material.

B. Roving: Unidirectional glass fiber mat, minimum 16 ounces per square yard weight.

C. Resins: Formulated for specified environment, minimum flame spread 25 in accordance with ASTM E 84, self-extinguishing in accordance with ASTM D 635.

D. Anchors: Manufacturer’s standard stainless steel fasteners.

E. Bonding Materials: Manufacturer’s standard frame-to-opening bonding system.

F. Joint Sealer: Sealant, specified in Section 07 92 00.

2.2 FABRICATION

A. General:
1. Sizes and Profiles: The required sizes for door and frame units, and the profile requirements are shown on the Drawings. Variable dimensions for profiles (if any) are shown along with maximum and minimum dimensions as required to achieve design requirements and coordination with other work.
2. The details shown are based upon standard details by one or more manufacturers. Similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/maximum profile requirements as shown.

2.3 HARDWARE

A. Flush Doors: Refer to Section 08 71 00, Finish Hardware, and to the frame, door and hardware schedules and details, for the furnishing and installing of hardware items. Hardware templates only will be furnished to the manufacturer for the fabrication of door and frames to receive hardware not supplied by door manufacturer.

B. Hardware Installation: Cut, reinforce, drill and tap frames and doors as required to receive hardware, except do not drill and tap for surface-mounted items until the time of installation. Comply with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.

2.4 MANUFACTURED UNITS

A. Non-rated Fiberglass Reinforced Plastic (FRP) Doors:
1. Thickness: 1-3/4 inches.
2. Thermal Insulating Value: >R factor 12.
3. Construction:
a. Style and Rail Structure: One-piece molded U-shaped cross-section, minimum 15 mil gel coat, minimum three (3) layers random-fiberglass mat, saturated with resins.

b. Core: End-grain balsa wood, resin-impregnated.
c. Face Sheets: Molded in one continuous piece, resin reinforced with hand-laid glass fiber mat, nominal 1/8 inch thick, minimum 15 mil gel-coated surface with minimum two (2) layers random-fiberglass mat ad one (1) layer roving, saturated with resins.
d. Door Edges: Minimum three (3) layers resin-reinforced glass fiber mat, nominal 3/8 inch thick, machine tooled.

4. Sizes: Indicated on Drawings.
5. Finish: Smooth gloss surface, minimum value 88 in accordance with ASTM D 523.
6. Color: To be selected by Engineer.

B. Non-rated Fiberglass Frames:
1. Construction: One-piece molded cross-section with molded stop, minimum 15 mil get coat, minimum two (2) layers random-fiberglass mat, saturated with resins polyurethane foam core. Sizes: For door sizes and frame depths indicated on drawings.
2. Frame Profile: 5-3/4 inches deep, 2 inches wide face; double rabbeted with 5/8 inch high stop.
3. Sizes: Indicated on Drawings.
4. Finish: Satin finish, with true and consistent color throughout frame thickness.
5. Color: To be selected by Engineer.

C. Product and Manufacturer: Provide one of the following:
1. Fiberglass Reinforced Plastic door and frames by Chem-Pruf Door Company.
2. Or Equal.

2.5 FABRICATION

A. Fiberglass Reinforced Plastic (FRP) Doors: Workmanship is to be of the highest quality in order to meet quality control requirements.
1. Stile and Rail Structure:
a. Form in mold of exact door size, with get coat layer to form, glass mat layers to a U-shaped channel interior.
b. Formulate get coat for environment and integral color specified.
c. Form structure as single component, jointed construction at intersections of stiles and rails is prohibited.
d. Form mortise for lockset, and recess for strike plate in lock stile, at time of molding.
e. Embed compression members at the time of molding in locations where thru-bolting of hardware is required.
2. Core:
a. Fit core material within stile/rail structure, fit around compression members and projections of mortises.
b. Mold openings for lites or louvers, if specified, form to sizes and at locations indicated.
3. Face sheets:

a. Formulate get coat with integral color specified, embed glass materials.
b. Chemically bond face sheets to stile/rail structure and core material.

B. Fiberglass Frames:
1. Resin transfer in mold of exact wall opening size, with get coat. Glass mat layers to form solid fiberglass outer surface.
2. Formulate get coat for environment and integral color specified.
3. Form structure of fiberglass components.
4. Form mortise for kick strike, and recess for strike plate in lock jamb, at time of molding.
5. Embed reinforcement for hinges and other indicated hardware in fiberglass matriz, provide for hinge leaf recesses in hinge jamb at time of molding.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and his installer must examine the substrate and conditions under which doors and frames Work are to be installed and notify the Engineer in writing of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.2 INSTALLATION

A. Install door opening assemblies in accordance with shop drawings, SDI-100, and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.

B. Installation of door hardware is specified in Section 08710.

C. Install door hardware in accordance with manufacturer's printed instructions, using through-bolts to secure surface applied hardware.

D. Site Tolerances: Maintain plumb and level tolerances specified in manufacturer's printed installation instructions.

3.3 CLEANING AND REPAIRING

A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding, and to remain in place at any angle without being moved by gravitational influence.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

C. Clean surfaces of door opening assemblies and sight-exposed door hardware in accordance with manufacturer's maintenance instructions.

D. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

+ + END OF SECTION + +

SECTION 08 3100

ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install all access doors and panels Work.
   2. Extent of access doors and panels is shown.
   3. Types of products required include the following:
      a. Wall access doors.
      b. Miscellaneous hardware, accessories and fasteners.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the access doors and panels Work.

C. Related Sections
   1. Section 04 0505, Unit Masonry Construction.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Copies of manufacturer's technical data and installation instructions for each type of access door and panel assembly. Transmit copy of the instructions for each type to the installer. Provide setting drawings, templates, instructions and directions for installation of anchorage devices.

PART 2 - PRODUCTS

2.1 DETAILS OF CONSTRUCTION

A. Description:
   1. Provide access door and panel assemblies manufactured as integral units and complete with all components and accessories ready for installation.

B. Masonry Wall Access Door: Provide the following wall access panel:
   1. Non-rated access door: 14-gauge galvanized steel door.
   2. Frames: 16-gauge galvanized steel with flanged
   3. Finish Hardware:
      a. Hinge: Continuous concealed piano hinge.
      b. Lock: Key operated cylinder lock with automatic dust shutter, stainless steel cam.
   4. Finish: Prime coat of rust inhibitive electrostatic powder, baked gray enamel.
   5. Size: 16-inches by 16-inches.
   6. Product and Manufacturer: Provide products of one of the following:
      a. Architectural Non-Rated Access Door by Nystrom.
      b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor must examine the areas and conditions under which access doors are to be installed and notify Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. Comply with manufacturer's instructions for installation of access doors and panels.

B. Coordinate installation with work of other trades.

C. Set frames accurately in position and securely attach to support with face panels plumb or level in relation to adjacent finish surfaces.

3.3 ADJUSTMENT AND CLEANING

A. Adjust hardware and panels after installation for proper operation.

B. Remove and replace panels or frames, which are warped, bowed or otherwise damaged.

END OF SECTION 08 3100

SECTION 08 3323

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install overhead coiling doors.
   2. Extent of overhead coiling doors is shown.
   3. Types of products required include:
      a. Aluminum, very high cycle, heavy-duty, overhead coiling doors with insulated slats and full perimeter weather-stripping.
      b. Chain operators.
      c. Electric operators and chain operators, control stations, starters, safety edge devices and similar and associated components with all power and control connections, including disconnect switches.
      d. Angles, brackets, hoods and supports.
      e. Inserts and anchoring devices.
      f. Miscellaneous materials and accessories for complete, functional system.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before overhead coiling door Work.

C. Related Sections:
   1. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM A36/A36M, Specification for Carbon Structural Steel.
   2. ASTM A366/A366M, Specification for Commercial Steel Sheet, Carbon, (0.15 maximum percent) Cold-Rolled.
   3. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   4. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.
   5. NEMA MG 1, Motors and Generators.
   6. NFPA 70, National Electrical Code.
   7. Standards for Safety, UL 10B, Fire Tests of Door Assemblies.
   8. UL, Building Materials Directory.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Supplier Qualifications: Supplier shall have a minimum of five years experience producing substantially similar products to those required and shall be able to document at least five installations in satisfactory operation for at least five years.

2. Installer Qualifications:
    a. Retain a single installer for all overhead coiling door Work, with documented and successful experience in type of Work required, and who is authorized representative of overhead coiling door manufacturer for installing and maintaining products required. Installer shall employ only tradesmen with successful experience in type of Work required.
    b. References: Provide names and telephone numbers of architects or engineers as applicable, and owner's representatives for at least three successful projects performed by proposed installer, similar to the Work required for this Project.

B. Component Supply and Compatibility:
    1. Obtain all products included in this Section regardless of component Supplier from one overhead coiling door manufacturer.
    2. Overhead coiling door Supplier shall review and approve or to prepare all Shop Drawings and submittals for all products provided under this Section.
    3. Components shall be suitable for specified service conditions and be integrated into overall assembly by overhead coiling door Supplier.

C. Regulatory Requirements:
    1. Comply with requirements of codes listed in Section 01 4100, Regulatory Requirements.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. Drawings showing all components and their assembly, all with accurate dimensions. Include details at frames, elevations of each overhead coiling door design type, details of construction and conditions at openings.
        b. Complete interconnecting wiring diagrams for power, signal and control systems indicating all system operating components and control station wiring required for complete, operational system complying with Specifications. Define and differentiate between components that are furnished and installed as part of overhead coiling door Work; both at the Site and in the factory, and those that must be furnished, or installed, as part of the Work under other Sections 26 0510 and 26 0519.
    2. Product Data:
        a. Manufacturer's specifications and data sheets, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door.
        b. Include manufacturer's data on operators, operating instructions and maintenance data. Indicate by transmittal form that installer has received a copy of diagrams and installation instructions.
        c. Electric operator and other operating system component specifications indicating compliance with Specifications. Provide motor nameplate data and ratings; characteristics, mounting arrangements, size and location of winding termination lugs, conduit entry and grounding lugs; and coatings.
    3. Samples:
        a. Specified galvanized, primed painted steel finish on 12-inch by 12-inch panel of insulated flat slats identical to those that will be used in the Work. Provide sample of full depth of door, demonstrating slat insulation and thermal-break feature. Engineer's review will be to determine acceptability of finish only.

B. Informational Submittals: Submit the following:
   1. Design Data:
      a. Calculations showing that detailing and fabrication of components complies with structural performance specified.
   2. Supplier Instructions:
      a. Provide manufacturer instructions for handling and installing specified products.
      b. Setting drawings; summary of loads on walls, jambs and structural elements; templates; and instructions and directions for installation of inserts and anchorage devices, furnished by overhead coiling door Supplier and installed under other Sections of these Specifications.
   3. Site Quality Control Submittals:
      a. Provide report of all operating tests, problems encountered, and corrective actions implemented. Document successful completion of field operating test for all products.
      b. Provide report of each visit to Site by Supplier's representative.
   4. Qualifications Statements:
      a. Supplier.
      b. Installer.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Provide complete operation and maintenance manuals, including test reports, maintenance data and schedules, description of operation, and information on recommended spare parts.
      b. Provide operation and maintenance manuals per Section 01 7823, Operation and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage devices to be embedded in concrete in ample time to prevent delaying the Work.
   2. Deliver products to Site suitably crated, braced, and protected against distortion and damage during transit and unloading. Label all parts to comply with approved Shop Drawings and submittals.
   3. Upon delivery, inspect products for damage. Notify Engineer in writing of loss or damage to products. Replace loss and repair damage to new condition in accordance with manufacturer's instructions. Minor damage may be repaired provided finished items are equal in all respects to new items and acceptable to Engineer; otherwise, remove and replace damaged items.
   4. Conform to Section 01 6500, Product Handling Requirements.

B. Storage and Protection:
   1. Store materials to allow easy access for inspection and identification. Keep all material off ground using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store doors and frames under cover.
   3. Place units up off floor in manner that prevents rust and damage.
   4. Avoid using non-vented plastic or canvas shelters.
   5. Conform to Section 01 6600, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
1. Structural: Overhead coiling door components shall be capable of resistance to these loads:
a. Wind Loading: Provide resistance to both positive and negative wind pressure loading of 30 pounds per square foot acting over entire plane of door curtain slats.
b. Dead Loading: Provide resistance to deformation of door components caused by effects of gravity loads.
c. Applied loadings shall not cause short-term or permanent deformation of system components. Doors shall remain operable and undamaged during and after application of specified wind pressure loading.
2. Helically-Wound Torsion Springs: Provide Very-High-Cycle design capable of performing for 100,000 operational cycles. Provide non-resetable electric counters for overhead coiling doors.
3. Electric Operators and Controls:
a. Operator system shall be constructed so that motor can be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.
b. Operators shall be constructed for 100,000 service-free, operating cycles.
c. Fixtures shall be listed and labeled as specified.
4. Chain Hoist Operation: Reduction roller chain and sprocket drive or suitable gearing, mounted on counterbalance shaft, shall operate with a maximum 35 pounds of pulling force.

B. Definitions:
1. Operating Cycle: One complete cycle of an overhead coiling door or fire-resistance-rated overhead coiling door begins in closed position. Door is then moved to open position and back to closed position.
2. Listed and Labeled: Per NFPA 70, Article 100.

2.2 MANUFACTURERS

A. Non-fire Resistance-Rated Overhead Coiling Doors:
1. Products and Manufacturers: Provide products of one of the following:
a. Thermo-Tite Door 800C Series Insulated Double Panel Overhead Coiling Doors, by Wayne Dalton Corp.
b. Weather-Tite Insulated Service Doors by McKeon Door Company.
c. Or equal.

2.3 MATERIALS

A. Door Curtain:
1. Door Curtain Slats: Fabricate door curtain of flat, interlocking slats, designed in compliance with structural performance criteria specified of continuous length for width of door, without splices.
2. Door Curtain Slats: Fabricate overhead rolling door curtain of flat interlocking slats designed to withstand the specified wind loading, of continuous length for the width of the door without splices. Provide aluminum slats back and front panels and finish as follows:
a. Finish:
1) Exterior Slats: NAAM AA-M21C22A41 (0.04" min.) Clear Anodized.

2) Interior Slats: NAAM AA-M21C22A41 (0.024" min.) Clear Anodized.

b. Slat Size and Features: 3/4-inches by three inches; pressure filled, foamed-in-place polyisocyanurate plastic insulation with minimum resistance to thermal flow (R) value of 6.25 and UL Tested Flame Spread of 75 maximum according to ASTM E84; thermal-break construction.

3. Endlocks: Heavy malleable iron castings, galvanized after casting, secured to curtain slats with two galvanized rivets. Provide endlocks on alternate curtain slats for curtain alignment and resistance against lateral movement.
4. Windlocks: Heavy malleable iron castings, galvanized after casting , and secured to curtain slats with three galvanized rivets. Space windlocks 2.0 feet on centers on both edges of curtain, or as required to comply with structural performance criteria specified.
5. Bottom Bar: Consisting of two galvanized steel angles, each not less than 1.5 inches by 1.5 inches by 1/8-inch thick.
6. Bottom Astragal: Replaceable gasket of flexible vinyl or neoprene.

B. Curtain Jamb Guides:
1. Fabricate curtain jamb guides of steel shapes with sufficient depth and strength to retain curtain against specified wind loading. Build-up units with minimum 3/16-inch thick steel sections complying with ASTM A36/A36M. Slot bolt holes for track adjustment.
2. Secure continuous wall angle to wall framing by 3/8-inch minimum diameter bolts at not more than 2.6 feet on centers, unless otherwise recommended by door manufacturer. Extend wall angles above door opening head to support coil brackets, unless otherwise shown. Place and locate anchor bolts on exterior wall guides so that they are concealed when door is closed.
3. Provide removable stops on guides to prevent over-travel of curtain, and a continuous bar for holding windlocks, if any.

C. Fascia Panels: Same material as door curtain slats.

D. Weather Seals:
1. Provide replaceable, compressible, and adjustable natural rubber or neoprene rubber weather-stripping for exterior doors. Secure weather seals with continuous metal pressure bars. At door heads, use a 1/8-inch thick replaceable, continuous sheet secured to inside of curtain coil hood. At door jambs, use a 1/8-inch thick continuous strip secured to exterior side of jamb guide.
2. Provide double guide weather-stripping that, when tested at 1.30 pounds per square foot pressure differential, allows maximum of 3.75 cubic feet per minute air infiltration per linear foot of overhead coiling door perimeter.
3. Provide weather-stripping continuously around all perimeter edges of door including hood baffle, astragal and guide weather-stripping.

E. Counterbalancing Mechanism:
1. Counterbalance doors by an adjustable-tension, steel helical torsion spring, mounted around steel shaft, mounted in spring barrel, and connected to door curtain with required barrel rings. Use grease-sealed ball bearings or self-lubricating graphite bearings for rotating members.
2. Counterbalance Barrel:
a. Fabricate spring barrel of hot-formed structural quality carbon-steel, welded or seamless pipe, of sufficient diameter and wall thickness to support roll-up of curtain without distorting slats and limiting barrel deflection to no more than 0.03-inch per foot of span under full load.

b. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance the weight of curtain with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.
c. Fabricate torsion rod for counterbalance shaft of case-hardened steel, of required size to hold fixed spring ends and carry torsional load.

3. Brackets: Provide mounting brackets of manufacturer's standard design, either cast-iron or cold-rolled steel plate with bell-mouth guide groove for curtain.

F. Weather and Waterproof Hoods:
1. Form to entirely enclose coiled curtain and operating mechanism at opening head, and act as weather seal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods, and portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
2. Fabricate steel hoods from 22-gauge hot-dip galvanized steel coating, complying with ASTM A653/A653M, phosphate-treat before fabrication.

2.4 ACCESSORIES

A. Manual Door Operators:
1. Provide manual operators, except where electric door operators are shown. When not shown, provide chain hoist operator units.

B. Chain Hoist Operator:
1. Provide manual direct drive chain hoist side-mounted operator consisting of endless stainless steel hand chain, chain cast-iron pocket wheel, and chain guard.
2. Provide chain hoist with self-locking mechanism allowing curtain to be stopped at all points in its travel and remain in position until movement is reactivated. Furnish hand chain with chain holder secured to operator guide.
3. Provide endless chain length that extends to 3.0 feet above floor.
4. Gears shall be high grade gray cast-iron.

C. Safety Stop Lock Bearings: Provide overhead coiling doors with safety stop lock bearings that will stop downward travel of overhead coiling door upon sensing a sudden, rapid acceleration of pipe shaft.

D. Electric Door Operators:
1. General: Provide electric door operator assembly of size and capacity recommended and provided by overhead coiling door manufacturer; complete with electric motor and factory pre-wired motor controls, including reversing starter, gear reduction unit, solenoid operated brake, clutch, remote control stations, and control devices and wiring complying with requirements of NFPA 70. Magnetic reversing starter shall be of internal type with thermal overload protection and reset button.
2. Provide operators and electric accessories suitable for use in NFPA 70, Class I, Division 1, Group D Hazardous Locations.
3. Provide hand-operated disconnect or mechanism for automatically engaging sprocket and chain operator and releasing brake for emergency manual operation. Mount disconnect and operator to be accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

4. Operator system shall be provided so that motor can be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.
5. Door Operator Type:
    a. Provide wall or bracket-mounted door operator units consisting of electric motor, a worm gear running-in-oil primary drive from motor to reduction gear box, chain or worm gear drive from reduction box to gear wheel mounted on counterbalance shaft, and quick-clutch disconnect-release for manual operation.
    b. Provide motor, clutch, and drive assembly of horsepower and design as determined by door manufacturer for size of door required and as specified.
6. Electric Motors:
    a. Provide high-starting torque, reversible, continuous-duty; Class A insulated electric motors, complying with NEMA MG 1, with overload protection.
    b. Size to start, accelerate, and operate door in either direction, from all intermediate positions, at not less than eight inches or more than twelve inches per second without exceeding nameplate ratings or considering service factor.
    c. Coordinate wiring requirements and current characteristics of motors with building electrical system, and refer to electrical Specifications.
    d. Provide totally enclosed, non-ventilated or fan-cooled motors, waterproof electric motors, fitted with a plugged drain, and controller with NEMA Type 4X enclosure.
    e. Provide adjustable limit switches, rotary-type, driven by time chain and interlocked with motor controls set to automatically stop door at fully opened and closed positions. Geared limit switches shall contain spare set of contacts.
7. Remote Control Station:
    a. Unless otherwise shown, provide momentary-contact, three-button control station with push button controls labeled, “OPEN”, “CLOSE”, and “STOP”. Provide at locations as shown or scheduled.
    b. Provide interior units, full-guarded type, surface-mounted, heavy-duty, with general-purpose NEMA 1 enclosure, unless otherwise shown.
    c. Provide exterior units, full-guarded type, standard duty, surface-mounted, weatherproof type, NEMA Type 4X enclosure, key-operated.
8. Safety Edge Device:
    a. Provide each door with pneumatic safety air switch, extending full width of door bottom, located within an U-shaped neoprene or rubber astragal mounted to bottom door rail.
    b. Unit shall operate such that contact with switch before fully closing will immediately change air chamber pressure sending signal from air switch to electric motor, that will stop downward travel and reverse door direction to fully opened position.
    c. Connect to control circuit through retracting safety cord with cable reels provided for each electric operating door.
    d. Compressible strip shall serve as a weather seal along bottom of door.
    e. Safety edge shall be acceptable for use in NFPA 70 Class I, Division 1 locations.

2.5 PAINTING

A. Surface-prepare in the shop and shop-prime all ferrous metal and galvanized surfaces, exposed and unexposed, except lubricated surfaces, with door manufacturer’s standard rust inhibitive primer, drying to a flat sheen.

B. Refer to Section 09 9100, Painting, and coordinate compatibility of shop and Site-primed and finished paint for interior and exterior ferrous and non-ferrous metals.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrates and conditions under which overhead coiling doors are to be installed and notify Engineer of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. Install, wire, connect and adjust doors, motors, starters, control stations, limit and safety switches and other electrical accessories and connections required, per manufacturer's written instructions, approved Shop Drawings and submittals, and the Contract Documents.

B. Lubricate bearings and sliding parts and adjust mechanism so moving parts operate smoothly and are free of warp, twist, or distortion and fit watertight for door's entire perimeter.

C. Adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment. Test door closing when activated by detector or alarm connected fire release system. Reset door-closing mechanism after successful test.

D. Repair damaged products and restore finish to match manufacturer's original finish.

3.3 FIELD QUALITY CONTROL

A. Tests: Perform operating tests on all products at the Site following installation of products, including controls. Should tests indicate malfunction, make necessary repairs and adjustments. Repeat tests and adjustments until, in opinion of Engineer, installation is complete and products are functioning properly and are ready for permanent operation.

B. Supplier's Services:
   1. Provide services of factory-trained representative of Supplier for installation supervision, start-up, operation testing, and training of Owner's operating and maintenance personnel. Representative shall make at least 1 visit to the Site with at least 2hours on-Site per visit (excluding travel time). First visit shall be to assist in installing products. Subsequent visits shall be for checking completed installation, start-up and training. Supplier's representative shall test-operate system in presence of Engineer and verify that each overhead coiling door conforms to requirements. Supplier's representative shall revisit Site as often as necessary until all installation is entirely satisfactory.
   2. Costs, including travel, lodging, meals and incidentals, for Supplier's representative's visits shall be at no additional cost to Owner.

END OF SECTION 08 3323

SECTION 08 4523

TRANSLUCENT FRP WINDOW ASSEMBLIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install translucent FRP window assemblies.
   2. The extent of the insulated translucent FRP window assemblies is shown and specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed prior to the insulated translucent FRP window assemblies Work.

C. Related Sections:
   1. Section 07 9200, Joint Sealants.

1.2 QUALITY ASSURANCE

A. Manufacturer's and Erector's Qualifications
   1. Sandwich panel system manufacturer must be listed by a recognized building code authority such as the International Conference of Building Officials, which requires quality control inspections by an approved agency.
   2. Quality control inspections and testing, conducted at least once each year shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with "Acceptance Criteria for Sandwich Panels" as regulated by the State and Local Building Codes or equivalent.
   3. Materials and products shall be manufactured by a company continuously and regularly employed in the manufacture of similar materials for a period of at least ten consecutive years; and which can show evidence of these materials being satisfactorily used on at least six projects of similar size, scope and type within such a period. At least three of the projects shall have been in successful use for five years or longer.
   4. Erection shall be by installer which has been in the business of erecting similar materials for at least five consecutive years; and can show evidence of satisfactory completion of projects of similar size, scope and type.

B. Performance Requirements: The manufacturer shall be responsible for the configuration and fabrication of the complete panel system.
   1. Panels shall resist a wind load of 35 pounds per square foot.
   2. System to conform to applicable sections of Ohio Building Code.
      a. Basic Wind Speed: 95 mph.
      b. Importance Factor: 1.15.
      c. Exposure Category: C
      d. Flat Roof Snow Load: 30 psf.
      e. Snow Importance Factor Is: 1.1
      f. Thermal Factor, Ct: 1.1

3. System to conform to applicable sections of Ohio Building Code.

1.3 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Samples of each required type and color of aluminum finish, on 12-inch long sections of extrusion shapes used in the Work, and 6-inch squares of sheet aluminum as required for the translucent FRP window and roof units and accessories. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is the exclusive responsibility of Contractor.
   2. Engineer reserves the right to require samples showing fabrication techniques and workmanship of component parts, and the design of accessories and other exposed auxiliary items for translucent FRP window assemblies Work, before fabrication of the Work proceeds.
   3. One of each type fastener employed, with statement of intended use. Samples will be reviewed by Engineer for material and color only. Compliance with other requirements is the exclusive responsibility of Contractor.

B. Shop Drawings: Submit for approval the following:
   1. Shop Drawings for the assembly and erection of the entire insulated translucent FRP window assemblies , showing all dimensions, gages, finishes, location of joints, connections, fasteners, expansion provisions, and locations and types of glazing gaskets, pressure plates and snap covers and other related items as required. Provide wall elevations at 1/4 inch scale, and full size detail sections of every typical composite member. Coordinate the submittal of Shop Drawings for component parts (as specified in other Sections) with this submittal. Show anchorages and alignments not shown on Shop Drawings of the components. Indicate clearly on Shop Drawings, all deviations from Engineer'S Drawings. Include structural calculations required to show compliance with wind pressure loading requirements in the Work.
   2. Copies of manufacturers' Specifications and installation instructions for required materials and components which are not included in the other submittals specified in other Sections of these Specifications. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.
   3. Maintenance Manual: Upon completion of the Work, furnish copies of detailed maintenance manual including the following information:
      a. Product name and number.
      b. Name, address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for light repairs such as dents, scratches and staining.

C. Test reports to be furnished by sandwich panel system manufacturer. The manufacturer shall submit certified test reports made by an independent testing organization for each type and class of panel system. Reports shall verify that the material will meet all performance requirements of this specification. Previously completed test reports will be acceptable if current and indicative of products used on this project. Test reports required are:
   1. Flame Spread and Smoke Development (ASTM E-84).
   2. Burn Extent (ASTM D-635).
   3. Color Difference (ASTM D-2244).
   4. Impact Strength (SPI Method).
   5. Bond Strength (ASTM C-297 and ASTM D-1002).

6. Accelerated Aging (ASTM D-1037).
7. Insulation "U" Factor (NFRC 100).

D. Proof of regular, independent quality control monitoring under a building code review and listing program shall be submitted.

E. Contractor shall submit written guarantee accompanied by test reports that state that the products to be furnished are in accordance with or exceed this specifications.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
1. Store translucent panels on the long edge, several inches above the ground, blocked and under cover to prevent warping.
2. Protect from weather and damage.
3. Store in designated areas as close as possible to point of installation.

1.5 GUARANTEE

A. Insulated Sandwich Panels: Submit copies of written guarantee agreeing to repair or replace panels which fail to perform as specified, including failure of the seal due to faulty manufacture of the unit for a period of 5 years.

PART 2 - PRODUCTS

2.1 PRODUCT AND MANUFACTURER

A. Provide one of the following:
1. Insulated Translucent FRP Window assemblies by Kalwall Corporation.
2. Insulated Translucent FRP Window assemblies by Major industries.
3. Or equal.

2.2 MATERIALS

A. Translucent Facing:
1. Translucent faces shall be manufactured from glass fiber reinforced thermoset resins by insulated translucent FRP window assemblies fabricator especially for architectural use.
2. Flammability: The interior face sheet shall have a flamespread rating no greater than 45 and smoke developed no greater than 350 when tested in accordance with ASTM E-84. Burn extent by ASTM D-635 shall be no greater than 1 inch. Faces shall not deform, deflect or drip when subjected to fire or flame.
3. Weatherability:
a. The full thickness of the exterior face shall not change color more than 3.0 Hunter or CIE Units (DELTA E by ATM D-2244) after five years outdoor South Florida weathering at 7 degrees facing south, determined by the average of at least three white samples without a protective film or coating to insure maximum, long-term color stability.
b. The exterior face shall have a permanent glass erosion barrier to provide maximum long-term resistance to reinforcing fiber exposure and shall be warranted against same for 25 years.

c. The exterior face shall have a self-cleaning thermoset acrylic urethane surface molecularly bonded under factory controlled conditions, minimum 1.2 mils thick, and fully field restorable if worn or damaged.

4. Appearance:
   a. The face sheets shall be uniform in color to prevent splotchy appearance. Faces shall be completely free of ridges and wrinkles which prevent proper surface contact in bonding to the aluminum grid core. Clusters of air bubbles/pinholes which collect moisture and dirt will not be acceptable.
   b. Exterior face sheets shall be .070 inches thick. Interior face sheets shall be .045 inches thick. Faces shall not vary more than 10 percent in thickness.
5. Strength: The exterior face sheet shall be uniform in strength and repel an impact equal to 60 ft/lbs without fracture or tear in accordance with SPI Shatter Resistance Test.
6. Translucent Facing Color: Colors are to be selected by Engineer.

B. Non-Combustible Grid Core:
1. The aluminum I-beams shall be 6061-t6, 6063-T6 or 6005-t5 with provisions for mechanical interlocking of muntin-mullion and perimeter to prevent high and low intersections which do not allow full bonding surface to contact with face material. Width of I-beam shall be no less than 7/16 inch. Aluminum I-beam for the grid shall be machined to tolerances of not greater than .002 inches.

C. Adhesive:
1. The laminate adhesive shall be heat and pressure resin type engineered for structural sandwich panel use. Adhesive shall pass testing requirements specified by the International Conference of Building Officials "Acceptance criteria for Sandwich Panel Adhesive".
   a. Initial bond strength between the face and the grid core shall be at least:
      1) 750 PSI tensile strength by ASTM C-297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D-1037.
      2) Shear strength average of four exposures by ASTM D-1002:
         a) 50 percent relative humidity at 68°F: 540 PSI.
         b) 182° F: 100 PSI
         c) Accelerated aging by ASTM D-1037 at room temperature : 800 PSI.
         d) Accelerated aging by ASTM D-1037 at 182° F:250 PSI.

2.3 PANEL CONSTRUCTION

A. Panels shall have a thickness of 2-3/4 inch with a "U" factor of .24, light transmission of 30 percent, and shading coefficient of 0.30.

B. Panels shall be fully removable and self-contained as a unit.

C. Translucent panels shall be a true sandwich panel of flat fiberglass sheets bonded to a grid core of mechanically interlocking aluminum I-beams and shall be laminated under a controlled process of heat and pressure. Tape bond systems are not allowed.

D. All grid patterns shall be as shown on Contract Drawings and be symmetrical about the horizontal center line of each panel.

E. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge. In order to insure bonding strength, white spots at intersections of muntins and

mullions shall not exceed four for each 40 square feet of panel, nor shall they be more than 3/64 inches in width.

2.4 BATTENS AND PERIMETER CLOSURE SYSTEM

A. Extruded 6061-T6 or T5and 6063-T6 or T5 aluminum screw clamp-tite closure system. Thermal break perimeter system shall be factory prefabricated with "U" = .50 or less.

B. All battens and perimeter closures to be supplied with 410 series stainless steel screws (excluding fasteners to the building).

C. Head, sill, jamb type channel members, closure members, and interior angles to have a minimum fillet of .090-inch to ensure strength at point of greatest stress.

D. Fasteners to the building shall be 300 Series stainless steel screws or bolts in expansion anchors of the size required to support the window system and as recommended by manufacturer.

2.5 FLEXIBLE SEALING TAPE

A. Sealing tape shall be manufacturer's standard pre-applied to closure system at the factory under controlled conditions.

2.6 ALUMINUM FINISHES

A. Anodized Couting:Architectural Class I clear anodized, type AA-M10C22A41

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and his installer must examine the substrate and conditions under which insulated translucent FRP window assemblies Work is to be installed and notify Engineer in writing of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. Comply with manufacturer's specifications and recommendations for the installation of FRP window system.

B. Set units plumb, level and true to line, without warp or rack of frames or sash. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

C. Refer to Section 07 9200, Joint Sealants.

3.3 ADJUSTMENT AND CLEANING

A. Clean aluminum surfaces promptly after installation, exercising care to avoid damage of the finish. Remove excess glazing and sealant compounds, dirt and other substances.

B. Advise Contractor of protective treatment and other precautions required through the remainder of the construction period, to ensure that window units will be without damage or deterioration, other than normal weathering, at the time of Final Acceptance.

END OF SECTION 08 4523

SECTION 08 5113

ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all aluminum windows Work.
   2. Extent of the aluminum windows is shown and specified.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the aluminum windows Work.

C. Related Sections:
   1. Section 08 8100, Glass Glazing.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Architectural Manufacturer's Association, (AAMA).
      a. AAMA101, Voluntary Specifications for Aluminum Prime Windows and Sliding Glass Doors.
      b. AAMA 302.8, Specification for Aluminum Windows.
      c. AAMA 701-702, Voluntary Specification for Pile Weatherstrip and Replaceable Fenestration Weatherseals.
      d. AAMA GS-001, Guide Specifications for Aluminum Architectural Windows.
   2. American Society for Testing and Materials, (ASTM).
      a. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
      b. ASTM B 221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      c. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
      d. ASTM D 523, Test Method for Specular Gloss.
      e. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
      f. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
      g. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
      h. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
      i. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
      j. ASTM E 283, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

k. ASTM E 330, Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
l. ASTM E 331, Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference.

3. Federal Specification, (FS).
   a. FS RR-W-365, Wire Fabric.
4. National Association of Architectural Metal Manufacturers, (NAAMM).
   a. NAAMM Metal Finishes Manual for Architectural and Metal Products.
5. Uniform Building Code, (UBC).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Installer's Qualifications:
   1. Installer shall be certified by the manufacturer of the aluminum windows to install the product accepted for this Project. Installer shall provide evidence of at least five years installing similar product to the product accepted for this Project as well as at least three references for projects where the exact product accepted for this Project has been successfully installed.
   2. Submit name and qualifications of the installer to the Engineer.

C. Component Supply and Compatibility:
   1. Obtain all products included in this Section regardless of the component manufacturer from a single aluminum window manufacturer.
   2. The aluminum window manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the aluminum window manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and installation of aluminum window units and associated components of the Work. Include wall elevations at 1/4-inch scale, typical unit elevations at 1-inch scale and full-size detail sections of every typical composite member. Show anchors, hardware, operators and other components not included in manufacturer's standard data, including glazing details. Indicate clearly on the Shop Drawings, all deviations from Contract Documents.
   2. Product Data:
      a. Copies of manufacturer's specifications, recommendations and standard details for aluminum window units, including fabrication, finishing, hardware and other components of the Work. Include certified test laboratory reports as necessary to show compliance with the requirements.
      b. Copies of manufacturers' specifications and installation instructions for required materials and components, which are not included in the other submittals, specified

in other Sections of these Specifications. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.

B. Informational Submittals: Submit the following:
   1. Test and Evaluation Reports: Certified laboratory test reports for required performance tests.
   2. Qualification Statements:
      a. Installer

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Documentation: Upon completion of the Work, furnish five copies of detailed maintenance manual including the following information:
      a. Product name and number.
      b. Name, address, e-mail address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for light repairs such as dents, scratches and staining.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Design Criteria:
   1. Except as otherwise shown or specified, the requirements for aluminum windows, and the terminology and standards of performance and fabrication workmanship, are those specified and recommended in AAMA 101, and the applicable general recommendations published by Architectural Aluminum Manufacturer's Association, National Association of Architectural Metal Manufacturers and Aluminum Association.
   2. All custom and standard features and finishes offered by the named manufac-turers shall be made available to Engineer from any “or equal” manufacturer submitted by Contractor.
   3. Custom High Performance Insulated Thermal-Barrier Aluminum Windows:

a. Performance and Testing: Except as otherwise specified, comply with the air infiltration tests, water resistance tests and applicable load tests specified in AAMA 101 for the type and classification of aluminum window units required in each case.
b. Comply with Architectural Performance Class and Section 4 “Optional Performance Grades” of AAMA 101 Group II-Compression Seal Window Products AP-AW50, Architectural.
c. Design Pressure:
    1) Provide uniform structural test pressure of 75 pounds per square foot.
    2) Air Infiltration Test, ASTM E 283: Maximum infiltration 0.065 cubic feet per minute per linear foot of operating ventilator when tested at 6.24 pounds per square foot differential pressure.
    3) Water Penetration Test, ASTM E 331: No water penetration for 15 minutes when window is subjected to rate of flow of five gallons per hour per square foot with differential pressure across window unit of ten pounds per square foot.
    4) Wind Load Test, ASTM E 330: Minimum 50 pounds per square foot positive and negative load for ten seconds. Maximum deformation of frame or sash member L/175 of span length.
d. Testing: Wherever manufacturer's standard window units comply with the requirements and have been tested in accordance with the specified tests, provide certification by the manufacturer of compliance with such tests; otherwise, perform the required tests through a recognized testing laboratory or agency and provide certified test results.
e. Provide internal drainage to lead all infiltrated water to the exterior through weep slots.
f. Other Loading: Applicable requirements of the Ohio Building Code.

2.2 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
    1. TR 7100 series fixed windows by Traco Architectural Systems, Inc.
    2. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Aluminum Extrusions: Alloy and temper, ASTM B 221, 6063-T5 and not less than 1/8-inch thickness at any location for mainframe sash members and tube supports. Vertical mullions and support clips as recommended by the window manufacturer.

B. Thermal Separator: Interior and exterior aluminum frame sections shall be thermally separated by a continuous urethane connector.

C. Fasteners: Stainless steel, guaranteed by the manufacturer to be non-corrosive and compatible with the aluminum window members, trim, hardware, anchors and other components of the window units.
    1. Do not use exposed fasteners, except where unavoidable for the application of hardware. Match the finish of the metal surrounding the fastener, unless otherwise specified.
    2. Provide Phillips flat-heat machine screws for exposed fasteners, unless otherwise specified.

D. Glazing Gaskets: Neoprene or EPDM.

E. Glass and Glazing Materials: Refer to Section 08 8100, Glass Glazing.

F. Hardware:
1. Projected-In Windows: Mullion mounted high-pressure die-cast zinc nickel-plated steel pawl cam-action in-line base locking handles with concealed pawl. Provide non-magnetic stainless steel keepers. Baked enamel aluminum color with lacquer finish.
2. Heavy-duty 6-bar hinges with stainless steel balance arms. Provide sliding pivots with nylon friction-adjustable shoe in a stainless steel track.
3. Concealed limited opening device.
4. Manufacturer: Provide the product of the following:
   a. Truth Division Sealed Power Corporation.

2.4 WINDOW CLASSIFICATION (GRADE)

A. AW-PG100-FW, Architectural Windows: Provide window units complying with the following :
1. Extruded aluminum-glazing stops of 0.062-inch minimum wall thickness, except 0.050-inch minimum for snap-on type.
2. Hardware and anchors of non-magnetic stainless steel and white bronze.
3. Fabricate units with all main corners and intersections of frame and sash mitered. Provide double tubular frame with hydraulically crimped gusset corner construction. Mortise or cope secondary members to fit, and weld in place with hairline joints.
4. Provide metal thickness as required to withstand performance requirements, but not less than 0.078-inch for frame members.
5. Provide means of drainage for water and condensation, which may accumulate in members of the window units.

2.5 FABRICATION AND ACCESSORIES

A. General: Provide specified manufacturer's standard fabrication and accessories, except to the extent more specific or more stringent requirements are specified. Include complete system for assembly of components and anchorage of window units, and prepare sash for glazing.

B. Sizes and Profiles: The required sizes for window units and the profile requirements are shown. The details shown are based upon standard details by one or more manufacturers. It is intended that similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/ maximum profile requirements specified.

C. Coordination of Fabrication: Wherever possible check actual window openings in the construction Work by accurate field measurement before fabrication, and show recorded measurements before fabrication, and show recorded measurements on final Shop Drawings. However, coordinate fabrication schedule with construction progress as directed by Contractor to avoid delay of the Work. Where necessary, proceed with fabrication without field measurements, and coordinate installation tolerances to ensure proper fit of window units.

D. Provide mullions and cover plates as shown, matching window units and complete with anchors for support to structure and for installation of window units. Allow for erection tolerances and provide for movements of window units due to thermal expansion and building deflections.

E. Provide extruded aluminum true-divided mullions, and custom aluminum panning as shown.

2.6 ALUMINUM WINDOW FINISHES

A. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded or factory-fabricated material. Provide a four-coat system complying with the following:
   1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
   2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold-water rinse. Seal with a chromic acid rinse and dry, except where manufacturer recommends another method to achieve greater coating reliability.
   3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.2 to 0.4-mils. Follow with a barrier coat 1.0-mils thick.
   4. Apply color coat containing mica pearlescent or metallic flakes over the barrier coat by roller coating for coil material and airless or Ransburg Elastrostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440°F for a dry film thickness of 0.7-mils for coil coating and 1.2-mils for spray coating so that today dry film is approximately 1.0-mil thick for coil material and 1.5-mil thick for extruded material.
   5. Apply clear fluoropolymer topcoat to provide a dry film thickness of 0.4 to 0.8-mils. The entire system shall have a dry film thickness of 2.6-mils, minimum.
   6. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to Engineer:
      a. Weathering, ASTM D 4214: Chalking, not more than No. 8, after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      b. Color Change, ASTM D 2244: No greater than 5 N.B.S units after removal of external deposits and after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      c. Humidity Resistance, ASTM D 2247: No blister after 3,000 hours.
      d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16-inch creep from areas scribed to bare metal after 3,000 hours.
      e. Dry Adhesion: No pick-off when tape tested over 1/16-inch cross hatch.
      f. Wet Adhesion: No pick-off when tape tested over 1/16-inch cross hatch; extruded material only.
      g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after one-hour immersion in distilled boiling water.
      h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water 80 ±10°F after 500 hours.
      i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67, minimum.
      j. Gloss, ASTM D 523: 30 ±5 reflectivity at 60°F.
      k. Pencil Hardness, ASTM D 3363: HB-H minimum.
      l. Dry Film Thickness: Primer, 0.2 to 0.4-mils, barrier coat, 1.0-mils, color coating, 0.7 to 1.5-mils; clear topcoat, 0.4 to 0.8-mils.
      m. Solvent Resistance: 100 Double MEK rubs, minimum.
      n. Flexibility, ASTM D 522: No cracking prior to metal fracture.
      o. Acid Resistance, ASTM D 1308: Sixteen hour spot test with five percent hydrochloric acid - no effect.
      p. Alkali Resistance, ASTM D 1308: Sixteen hour spot test with five percent sodium hydroxide - no effect.

B. Color:
   1. Full selection of manufacturer's standard, custom and premium colors for final selection by Engineer.

2. Engineer will select custom special extended life premium colors for aluminum windows at time of Shop Drawing and sample submission review.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the substrate and conditions under which custom aluminum window system Work is to be installed and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. Comply with manufacturer's specifications, installation manuals and recommendations for the installation of window units, hardware, operators, and other components of the Work.

B. Erection Tolerances:
   1. Limit variations from plumb, level or dimensioned angle to the following:
      a. 1/8-inch maximum deviation in story height or in 10-foot vertical or angular run, and in 20-foot horizontal runs.
      b. 1/4-inch maximum deviation in 40 foot runs, all directions.
   2. Limit variations from theoretical member locations shown, based on established floor lines and column lines, including variations from plumb and level, to the following:
      a. 3/8-inch total maximum deviation for members at all locations.
      b. 1/8-inch maximum change in deviation for members for ten foot runs, all directions.
   3. Limit offsets in end-to-end and edge-to-edge alignments of adjoining and consecutive members, which form planes, continuous runs and profiles, to the following:
      a. 1/16-inch maximum offset in flush alignment, including members, which are to be 1/2-inch or less out-of-flush, and including members, which are separated 2-inches or less by a reveal or protrusion in the plane of the aluminum window wall.
      b. 1/8-inch maximum offset in alignments, which are to be out-of-flush by more than 1/2-inch, or separated by a reveal or protrusion of more than 2- inch width.

C. Anchor units securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

D. Refer to Section 07 9200, Joint Sealants, for compounds, fillers and gaskets to be installed concurrently with window units.

E. Do not install component parts, which are observed to be defective in any way, including warped, bowed, dented, abraded and broken members, and including glass with edge damage.

F. Do not cut, or trim, component parts during erection, in a manner, which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance of the aluminum window wall. Return component parts, which require alteration to the shop for refabrication, if possible, or for replacement by new parts.

G. Install component parts level, plumb, true to line and with uniform joints and reveals. Secure to structure with non-staining and non-corrosive shims, anchors, fasteners, spacers and fillers. Use

erection equipment, which will not mar or stain finished surfaces, and will not damage the component parts.

H. Apply a bituminous coating of approximately 30-mil dry film thickness, or other suitable permanent separator, on concealed contact surfaces of dissimilar materials before installation, wherever there is the possibility of corrosive or electrolytic action.

I. Anchor component parts securely in place as shown, by bolting, or other permanent mechanical attachment system, which will comply with performance requirements and permit movements, which are intended or necessary. Install slip-joint linings to ensure movement as intended or necessary.

J. Clean debris, dust and other substances from behind the aluminum window wall as it is erected, and provide temporary closures if necessary to prevent the accumulation of such substances in the void spaces behind the aluminum window walls.

K. Install thermal barrier between pressure plate and mullion.

L. Attach pressure plate with screws. Install snap covers over pressure plates.

M. Install glazing using dry glazing retainers, which provide a firm but resilient clamping grip on the glazing.

N. Refer to Section 08 8100, Glass Glazing, for installation requirements.

O. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage of the finish. Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts.

P. Advise Contractor of protective treatment and other precautions required through the remainder of the construction period, to ensure that window units will be without damage or deterioration, other than normal weathering, at the time of Final Completion.

Q. Maintain the aluminum window wall in a clean condition throughout the construction period, so that it will be without any evidence of deterioration or damage, other than the effects of normal weathering, at the time of Final Completion. Select methods of cleaning which will promote the achievement of uniform appearance and stabilized colors and textures for materials that weather or age with exposure.

R. Contractor shall advise Engineer, in writing, of protection and surveillance requirements that Contractor shall provide at no additional cost to the Owner, to ensure that the aluminum windows Work will be without deterioration or damage at the time of Final Completion by Owner.

S. Remove and replace with new material aluminum window components, which have been damaged, including finish, beyond successful repair, as directed by Engineer. Repair minor damage.

T. Immediately before the time of Final Completion, clean the aluminum windows thoroughly, inside and out. Demonstrate proper cleaning methods to Owner'S maintenance personnel during this final cleaning.

U. At the completion of the Work, clean or replace adjacent work, marred by the Work of this Section.

V. Remove all materials and debris and leave the Site of the Work in clean condition.

3.3 FIELD QUALITY CONTROL

A. Water Penetration Test: Perform test in accordance with NAAMA Standard FC-1: "Field Check for Water Leakage of Metal Curtain Walls", except limit test area to one bay wide (but not less than 20 feet or more than 40 feet) by one story high, located from mid-bay to mid-bay and from mid-story-height to mid-story-height.

B. Depending upon the prevalence or absence of leakage in the initial water penetration test, and upon measures adopted by the aluminum window wall Contractor to eliminate sources of leakage from subsequently erected work, the Engineer will determine the necessity, and scope of, additional tests. In no case will the total of tested area amount to less than one percent, nor more than ten percent of the aluminum window wall area, except as subsequently authorized by the Engineer.

END OF SECTION 08 5113

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SECTION 08 7100

DOOR HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install door hardware. Furnish door hardware for all doors in compliance with these Specifications herein.
2. Extent of door hardware is specified. Door hardware is defined to include all items known commercially as door hardware, except special types of unique and non-matching hardware specified in the same Section as the door and door frame.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the door hardware.
2. Coordinate the Work of other Sections to provide clearances and accurate positioning of recessed or cast-in-place items.

C. Related Sections:
1. Section 08 1113, Hollow Metal Doors and Frames.
2. Section 08 1116, Aluminum Doors and Frames.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
1. American National Standards Institute, (ANSI).
   a. ANSI A117.1, Accessible and Usable Buildings and Facilities.
2. American National Standards Institute, (ANSI), in association with Builders Hardware Manufacturers' Association, (ANSI/BHMA).
   a. ANSI/BHMA A156.1, Butts and Hinges.
   b. ANSI/BHMA A156.3, Exit Devices.
   c. ANSI/BHMA A156.4, Door Controls - Closers.
   d. ANSI/BHMA A156.6, Architectural Door Trim.
   e. ANSI/BHMA A156.7, Template Hinge Dimensions.
   f. ANSI/BHMA A156.8, Door Controls - Overhead Stops and Holders.
   g. ANSI/BHMA A156.13, Mortise Locks and Latches, Series 1000.
   h. ANSI/BHMA A156.16, American National Standard for Auxiliary Hard-ware.
   i. ANSI/BHMA A156.18, Hardware - Materials and Finishes.
   j. ANSI/BHMA A156.21, Thresholds.
   k. ANSI/BHMA A156.22, Door Gasketing and Edge Seal Systems.
3. ANSI, in association with Door and Hardware Institute, (ANSI/DHI).
   a. ANSI/DHI A115.1, Preparation of Mortise Locks in 1-3/8-inch and 1-3/4-inch Standard Steel Doors and Frames.
4. ANSI, in association with National Fire Protection Association, (ANSI/NFPA).
   a. ANSI/NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
5. ANSI, in association with Underwriters' Laboratories, Inc., (UL).

a. UL 10B, Fire Tests of Door Assemblies.

6. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG).
7. Door and Hardware Institute, (DHI).
   a. DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
   b. DHI, Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.
   c. DHI, Sequencing and Format for the Hardware Schedule.
8. Hollow Metal Manufacturers Association, Division of National Association of Architectural Metal Manufacturers, (HMMA).
   a. HMMA 830, Hardware Preparation and Locations for Hollow Metal Doors and Frames.
9. National Fire Protection Association, (NFPA).
   a. NFPA 80, Fire Doors and Fire Windows.
10. Steel Door Institute, (SDI).
    a. SDI 109, Hardware for Standard Steel Doors and Frames.
    b. SDI 118, Basic Fire Door Requirements.
11. Underwriters' Laboratories, Inc., (UL).
    a. UL 305, Panic Hardware.
    b. UL, Building Materials Directory.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Provide door hardware and accessories manufactured by firms specializing in the production of this type of Work and complying with specified standards of ANSI, BHMA, DHI, NFPA, HMMA, SDI and UL.
   2. Provide door hardware from manufacturers who are members of BHMA and participate in BHMA certification programs.

B. Installer's Qualifications:
   1. The door hardware installer shall have in his employ an architectural hardware consultant. The architectural hardware consultant shall be a member of the Door and Hardware Institute, (DHI), who has passed the DHI certification examine and successfully completed an apprenticeship program. The architectural hardware consultant shall be responsible for preparing door hardware schedules and Shop Drawings and be present at the Site for the purpose of checking and supervising the Work of the installer during the time of installation and adjustment of the door hardware Work, and shall prepare a written field report on status of completed door hardware installation as specified.
   2. Submit name and qualifications of the installer to Engineer.

C. Requirements of Regulatory Agencies:
   1. Provide door hardware for fire-resistance-rated openings in compliance with NFPA 80.
   2. Provide only door hardware that has been tested, listed and labeled by UL for the types and sizes of doors required, and complies with the requirements of the door and door frame labels.
   3. Modify features of door hardware items specified, and provide additional accessories and features as required to meet UL and NFPA requirements, at no additional cost to the Owner.

D. Codes: Comply with applicable requirements of codes.

E. Source Quality Control:
   1. Obtain each type of door hardware item from only one manufacturer.
   2. Provide door hardware schedule, for submission to, and for approval by, Engineer, prepared in compliance with DHI standards.
   3. Comply with specified BHMA standards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Copies of manufacturer's data for each item of door hardware. Include whatever information may be required to show compliance with specified requirements, and include instructions for installation and for maintenance of operating parts and exposed finishes. Include mounting heights and locations for each item of door hardware. Provide Engineer with latest complete technical catalogue of all available door hardware manufactured by proposed manufacturers, even if manufacturer specified by Engineer is submitted by Contractor to perform the Work. Furnish templates to fabricators of other Work, which is to receive door hardware.
   2. Shop Drawings:
      a. Copies of the Door Hardware Schedule in the manner and format specified, complying with the actual construction Progress Schedule requirements (for each draft). Include explanation of abbreviations, symbols, and codes used to present scheduled information.
         1) Prepare and submit Door Hardware Schedule in compliance with HDI standards.
      b. Based on the door hardware requirements specified, organize the final Door Hardware Schedule into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other Work (such as hollow metal frames) which may be critical in the Project Schedule. Furnish final draft of schedule after Samples, manufacturer's data sheets, coordination with Shop Drawings for other Work, delivery schedules and similar information have been completed and accepted.
      c. Include a separate key schedule, showing clearly how Owner’s final instructions on keying of locks have been fulfilled.
      d. Door Hardware Schedules are intended for coordination of the Work. Review and acceptance by Engineer does not relieve Contractor of responsibility to fulfill the requirements as shown and specified.

B. Submittals: Submit the following:
   1. Test and Evaluation Reports:
      a. Certified independent laboratory test reports for BHMA certification program and certification tests for each type of product specified.
   2. Qualifications Statements:
      a. Installer.

C. Submittals: Submit the following:
   1. Operation and Maintenance Documentation: Upon completion of the Work, furnish five copies of detailed maintenance manuals, including the following information:

a. Product name and manufacturer.
b. Name, address, e-mail address and telephone number of manufacturer and local distributor.
c. Detailed procedure for routine maintenance and cleaning.
d. Detailed procedures for repairs such as dents, scratches and staining.
e. Parts identification manual and maintenance manuals for each piece of door hardware.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
2. Deliver all items of door hardware in manufacturer's original, undamaged packages, bearing accurate representation of the item within each package.
3. Pack each piece of door hardware separately, complete with screws, keying, instructions and templates, tagged to correspond with items submitted on approved Shop Drawings and as specified.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Provide secure storage area for door hardware items, secured by locks and accessible only to door hardware installer, Engineer and Contractor.
3. Store door hardware in manufacturers' original packages.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Items that arrive in a damaged condition shall be removed from the Site and not offered again for acceptance. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Description:
1. Where the door, shape, size, fire-resistance-rating, frequency of use, or function of a member receiving door hardware is such as to prevent, or make unsuitable, the types of door hardware specified, furnish similar types having as nearly as practicable the same operation but of type or kind more appropriate to the design intension and requirements of governing authorities having jurisdiction at the Site. Clearly identify and highlight to Engineer all such required modifications on Shop Drawings submitted for approval.
2. If door hardware for any location is not specified, provide door hardware equal in design and quality to adjacent door hardware specified for comparable openings at no additional cost to Owner.

3. Furnish door hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements, as necessary for proper installation and function.
4. Unless otherwise specified, comply with DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames and Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.

2.2 DETAILS OF CONSTRUCTION

A. General:
1. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of door hardware for proper installation and operation of the door swing as shown.
2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with labels required by governing authorities having jurisdiction at the Site.
3. Base Metals: Produce door hardware units of the basic metal and forming method specified, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not substitute materials or forming methods for those specified.
4. Fasteners: Manufacture door hardware to conform to published templates, generally prepared for machine screw installation. Do not provide door hardware, which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
5. Furnish screws for installation, with each door hardware item. Provide Phillips flat-head screws except as otherwise specified. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces on other Work, to match the finish of such other Work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
6. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of door hardware, base material or fastener.
7. Provide concealed fasteners for door hardware units, which are not exposed when the door is closed, except to the extent no standard manufacturer units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other Work under any condition, except where it is not possible to adequately reinforce the Work and use machine screws or concealed fasteners of another standard type to satisfactorily avoid the use of through bolts.
8. Tools for Maintenance: Furnish two complete sets of specialized tools as required for Owner's continued adjustment, maintenance, removal and replacement of door hardware.

B. Mortise Hinges:
1. Templates and Screws: Provide only template-produced units.
2. Base Metal: Except as otherwise specified, fabricate hinges from stainless steel and finish to match the latch and lock set.
3. Number of Hinges: Provide three hinges on each door leaf of less than 60-inches in height; provide one additional hinge for next 30-inches of door height or fraction thereof; provide two additional hinges for each 30-inches, or fraction thereof, for doors above 90-inches tall.
4. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
   a. Interior Doors:
      1) Average Use, Maximum 36-Inches Wide: 4-1/2-inch standard weight (0.134-inches).

2) Heavy Use, Maximum 36-Inches Wide: 4-1/2-inch heavy-weight (0.180-inches).

b. Exterior Doors, Maximum 36-Inches Wide: 4-1/2-inch heavy-weight (0.180-inch).

5. Types of Hinges: Provide full-mortise type, ball-bearing hinges, swaged for mortise applications, inner leaf beveled, square cornered, unless manufacturer's recommendations indicate that half-mortise, half-surface, full-surface or other type should be used for the frame and door type or condition.
6. Hinge Pins: Except as otherwise specified, provide hinge pins as follows:
   a. Pins: Stainless steel.
   b. Exterior Doors: Non-removable pins. Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.
   c. Tips: Slope ends of hinge barrel.
7. Conform to ANSI/BHMA A156.7.
8. Comply with UL, List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
9. Products and Manufacturers: Provide one of the following:
   a. FBB 199 and FBB 191 by Stanley Commercial Hardware, Division of The Stanley Works.
   b. T4B3386 and TB3313 by McKinney Products Company, Division of ESSEX Industries, Incorporated.
   c. Or equal.

C. High-Security Mortise Locks and Latch Sets:
1. Strikes: Provide manufacturer's standard wrought box strike, for each location and use shown. Provide stainless steel curved lip strikes, unless otherwise recommended by manufacturer, finished to match lock or latch set trim.
2. Lock Throw: Provide minimum of 3/4-inch anti-friction latch bolt and 1-inch dead bolt throw. Comply with UL requirements for throw of latch bolts and deadbolts on fire-resistance-rated openings.
3. Materials: Provide the following features and materials:
   a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
   b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
   c. Case: Wrought steel, zinc dichromatized.
   d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
   e. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
   f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
   g. Hubs: Sintered steel, copper infiltrated.
   h. Lever with Stop Pin: Brass, plated to match stainless steel, with additional built-in stop to prevent over-torquing of lever.
   i. All components shall be of marine quality, wherever possible.
4. Backset: 2-3/4-inches.
5. Modify specified locks and latches to comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
6. Finish: US 32D satin.
7. Conform to ANSI/BHMA A156.13, Series 1000, Security Grade 1.
8. Products and Manufacturers: Provide one of the following:
   a. High Security SL8700 Mortise Lockset Augusta - ASL Lever Handles and Trim by Yale Security, Incorporated, Division of Yale Security Group.

b. Or equal.

D. Panic Exit Devices:
1. Exit Doors: Where required by governing authorities having jurisdiction at the Site, provide panic exit devices, of the type required, including UL labels.
2. Fire Doors: Where shown or specified as a fire-resistance-rated door, provide units listed and labeled by UL, to comply with the fire-resistance-rating and size of door shown.
3. Strikes: Provide manufacturer's standard wrought stainless steel jamb-mounted top latch bolt and bottom latch bolt for each location and use shown to allow independent opening and closing of each leaf of double doors with panic exit devices; complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
4. Lock Throws: Provide minimum of 3/4-inch latch bolt throw complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
5. Provide concealed vertical rod type exit device and mortise type exit devices as specified.
6. Provide the following features and materials:
   a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
   b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
   c. Case: Wrought steel, zinc dichromatized.
   d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
   e. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
   f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
   g. Hubs: Sintered steel, copper infiltrated.
   h. Crossbar: Oval, seamless with interlocking expansion collets and roll pins; knurled, satin stainless steel, 0.062-inches minimum thickness, with steel reinforcing tube.
   i. Concealed bolts: Minimum 1/2-inch diameter, stainless steel.
7. Backset: Provide minimum backset of 2-3/4-inches.
8. Finish: US 32D satin.
9. ANSI/BHMA: A156.3, Type 3 and Type 8, Grade 1; F08, entrance by lever, key locks or unlocks lever for entrances shown as accessible to people with disabilities as required by ADAAG; and F05, entrance by thumb piece, key locks or unlocks thumb piece.
10. Products and Manufacturers: Provide one of the following:
    a. 1530-L8 (F) and -T8 (F) Series Mortise Exit Devices and 1520(F) CVR Concealed Vertical Rod Exit Devices; with Escutcheon Trim and Augusta - ASL Lever Handles and Thumbpiece/Handle/Cylinder Unit by Yale Security, Incorporated, Division of Yale Security Group.
    b. Or equal.

E. Cylinders and Keying System:
1. Standard System: Except as otherwise specified, provide new master key system for the Project.
2. Multiple-Building System: Except as otherwise specified, provide new grandmaster key system for Project.
3. Existing System: Grandmaster key or great-grandmaster keys the locks to Owner’s existing system, with a new master key for the Project.
4. Review the keying system with Owner’s and provide the type required (master, grandmaster or great grandmaster), either new or integrated with Owner’s existing system.
5. Furnish all locks with manufacturer's cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these before

Substantial Completion. Construction control keys and cores shall not be part of Owner's permanent keying system. Permanent cores and keys shall be furnished to Owner prior to Substantial Completion.

6. Comply with the Owner's instructions for master keying and, except as otherwise specified, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.
7. Permanent keys and cores shall be stamped with the applicable key mark for identification. These visual key control marks or codes shall not include the actual key cuts. Permanent keys shall also be stamped "DO NOT DUPLICATE".
8. Cylinder Material: Brass, bronze or Series 300 stainless steels.
9. Cylinder Features: Seven-pin, high-security, removable core.
10. Key Material: Nickel silver.
11. Key Quantity: Furnish three keys for each lock and five keys for each master and grandmaster system. Provide one extra key blank for each lock.

F. Overhead, Surface-Mounted, Door Closers:

1. Provide all doors, unless specially shown or specified as being provided with floor-mounted or concealed overhead closers, with surface-mounted overhead door closers. Provide both active and inactive door leafs with closers.
2. Size of Units: Except as otherwise specified, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.
3. Where parallel arms are specified, and for closers on exterior doors, provide closer unit one size larger than recommended for use with standard arms.
4. Use parallel arm arrangement for doors that would otherwise have the door closer appearing in finished corridors or entries.
5. Comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials, and NFPA 80. Modify closers specified as required.
6. Provide hold open feature for all non-fire-resistant-rated doors, unless otherwise specified.
7. Provide corner bracket mounting on exterior doors. Select all arms to clear weather-stripping, and overhead door holders.
8. Provide long arm to allow door to swing 180 degrees where long arm will eliminate floor-mounted stops.
9. Provide closers with spring power adjustment feature capable of increasing spring power 15 percent minimum in all closer sizes.
10. Provide individual regulating valves for closing and latching speeds, and separate adjustable back check valve.
11. Provide delayed closing action feature on all door closers. Position valve at top of closure.
12. Provide the following materials and features:
    a. Full Metal Cover: Aluminum.
    b. Case: Cast-iron.
    c. Arms: Plated to match full metal covers.
    d. Other Parts: Steel.
    e. Extreme temperature fluid.
    f. Security torx machine screws.
    g. Ten-year warranty.
    h. Provide manufacturer's optional corrosion protection.
13. Finishes: US 26D satin chrome. Color coordinate all arms and other accessories.
14. Highly Corrosive Atmospheres: Provide all closers with specified manu-facturer's optional corrosion protection.
15. ANSI/BHMA: A156.4, C02011, in compliance with PT 1 and PT 4.

16. Products and Manufacturers: Provide one of the following:
    a. DC2000DA M71, M73, M74, M75, M87 by Corbin Russwin, Incorporated, Division of Yale Security Group.
    b. Or equal.

G. Heavy-Duty, Concealed Overhead Holders and Stops:
1. Provide heavy-duty, concealed overhead holders and stops on all exterior and all interior doors, unless otherwise specified to receive an extra heavy-duty overhead holder and stop in List of Door Hardware Items at end of Part 3. Comply with UL and NFPA requirements for hold-open feature.
2. Provide the following features and materials:
    a. Shock Absorber Spring: Heavy tempered steel.
    b. Channel: Heavy-gauge brass.
    c. All other Parts: Stainless steel.
    d. Adjustment: Degree of hold-open and stop shall be adjustable after installation.
3. Finish: US 32D satin.
4. Coordinate placement of concealed overhead holder and stop with overhead closers.
5. ANSI/BHMA: A156.8, C51511.
6. Products and Manufacturers: Provide one of the following:
    a. Heavy-Duty 100H (ADJ) Series Concealed Holders and Stops by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
    b. Or equal.

H. Flush Bolts:
1. Provide flush bolts on the inactive leaf of all pairs of doors, unless otherwise specified.
2. Provide flush bolts at the top and bottom of door.
3. Provide downset of 12-inches for all automatic flush bolts, and manufacturers' automatic flush bolt strikes, for the locations specified in List of Door Hardware Items at end of Part 3.
4. Comply with UL, Hardware, Automatic or Surface Bolts, and NFPA 80, for automatic flush bolt requirements.
5. Provide the following features and materials:
    a. Automatic Flush Bolts: All parts bronze.
    b. Flush Bolt Levers: Forged Brass.
    c. Flush Bolt Plate: Forge Brass.
    d. Flush Bolt Guide and Strike: Wrought Brass.
    e. Flush Bolt Rods: 1/2-inch round rods, bronze, 12-inches minimum length.
    f. Bolt Head: Brass.
6. Provide extension flush bolts with 3/4-inch throws and with top bolt not over 6 foot-0 inches above finished floor. Provide bottom flush bolt 12-inches long.
7. ANSI/BHMA: A156.16: L14081, L14251 and L14091.
8. Products and Manufacturers: Provide one of the following:
    a. GJ FB6 Extension Flush Bolts by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
    b. Or equal.
9. Where required by governing authorities having jurisdiction at the Site, provide cast bronze automatic flush bolts bearing the UL label.
10. Products and Manufacturers: Provide one of the following:
    a. GJ FB30 Automatic Flush Bolts by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
    b. Or equal.

I. Coordinators:
   1. Provide coordinator device on all pairs of doors required or specified to have automatic flush bolts, or panic exit devices. Comply with UL, List of Inspected Fire Protection Equipment and Material, and NFPA 80 requirements.
   2. Provide manufacturer's standard units equipped with a safety release mechanism which allows the active leaf to close if under extreme pressure and whose active door lever, located nearest the active door stop, holds the active door ajar until the trigger mechanism is released to the retracted position by the closing of the inactive leaf.
   3. Materials: Anodized aluminum.
   4. Finish: US 27 satin.
   5. ANSI/BHMA: A156.3, BHMA 5.1, Type 21A.
   6. Products and Manufacturers: Provide one of the following:
      a. COR 1, 2 and 3 Series with FB Series by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
      b. Or equal.

J. Astragals:
   1. Provide metal astragal bar, not less than 1/8-inch by 2-inches, for exposed flathead screw mounting on active leaf of all pairs of doors. Comply with UL and NFPA requirements for types and locations of astragals.
   2. Provide astragal of cold-rolled steel with prime painted finish.
   3. Provide astragal of extruded aluminum with clear anodized finish.
   4. Products and Manufacturers: Provide one of the following:
      a. No. 357 Series by Pemko Manufacturing Company.
      b. Or equal.

K. Dust-Proof Strikes:
   1. Provide brass dust-proof strikes, which incorporate a slotted plunger raised to flush position by spring tension for all flush bolts.
   2. Provide 5/8-inch inside diameter dust-proof strikes; threshold mounted and surface mounted.
   3. Finish: US 26D satin chrome.
   4. ANSI/BHMA: A156.16, L14011-L14012.
   5. Products and Manufacturers: Provide one of the following:
      a. DP-1 and DP-2 by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
      b. Or equal.

L. Door Pulls, Push and Protection Armor:
   1. Door Pulls: Provide heavy-duty surface-mounted door pulls with pull plates where specified in List of Door Hardware Items at end of Part 3.
      a. Door pulls shall be stainless steel US 32D and have 1-inch diameter 12-inch long handles which project 2-1/2-inches from pull plate surface.
      b. Pull plates shall be 8-inches by 16-inches, stainless steel US 32D; 0.050-inches thick.
      c. Provide all non-removable fasteners.
      d. Pulls shall be fastened to plates at factory.
      e. ANSI/BHMA: A156.6, J405; B3E.
      f. Products and Manufacturers: Provide one of the following:
         1) 40 Series Pull Plates and Handles by Hager Hinger Company.
         2) Or equal.
   2. Push Plates:

a. Provide 0.125-inch thick stainless steel plate with No. 4 finish.
b. Size: 8-inches by 16-inches with beveled edges.
c. ANSI/BHMA: A156.6, J304; B3E.
d. Products and Manufacturers: Provide one of the following:
1) 80S Beveled by Hager Hinger Company.
2) Or equal.

3. Protection Armor:
a. Provide one armor plate per leaf of each door scheduled to receive armor-plate protection.
b. Provide 16-gauge stainless steel with No. 4 finish 2 foot-0 inches high by 12-inches less in width than width of door.
c. ANSI/BHMA: A156.6, J101; B3E.
d. Products and Manufacturers: Provide one of the following:
1) 193S Beveled Stainless Steel Armor Plate by Hager Hinge Company.
2) Or equal.

M. Stripping and Seals:
1. Provide perimeter weather stripping at all exterior doors. Provide stripping and seals for interior doors where scheduled in List of Door Hardware Items at end of Part 3.
2. Continuity of Stripping: Except as otherwise specified, stripping at each opening shall be continuous and without unnecessary interruptions at door corners and hardware.
3. Replaceable Seal Strips: Resilient or flexible seal strip of every unit shall be easily replaceable and readily available from stocks maintained by the manufacturer.
4. Provide bumper-type weather-stripping at jambs and head, including a resilient insert and metal retainer strip, surface-applied, of the following metal, finish and resilient bumper material:
a. Housing: Extruded aluminum with dark bronze anodized finish; 0.062-inch minimum thickness of main walls and flanges.
b. Dimensions: 1-3/8-inches by 7/8-inches, stop-mounted.
c. Seals: Closed-cell extruded silicone.
d. ANSI/BHMA: A156.22, R3E264.
e. Products and Manufacturers: Provide one of the following:
1) No. 350DSPK and 2891 DPK (for parallel arms) by Pemko Manufacturing Company.
2) Or equal.

N. Thresholds:
1. All exterior and interior doors shall be provided with thresholds.
2. Metal: Mill finish extruded bronze.
3. Surface Pattern: Fluted tread, manufacturer's standard.
4. Provide countersunk stainless steel screws and expansion shields.
5. Width: Five-inches wide and of length sufficient to span full width of rough openings, coped and scribed neatly at and around door frames.
6. Construction:
a. Single-piece, complying with manufacturer's recommendations.
7. Profile: Provide manufacturer's unit, which conforms to the minimum size and profile requirements specified.
a. Floor Drop: Except where no change in floor elevation is shown from one side of threshold to the other, provide profile that accommodates 1/2-inch drop in floor elevation, unless another dimension is shown.

b. For doors equipped with panic hardware, including floor bolts, provide profile with stop bar of proper size and shape to function as the strike plate for the floor bolts.

8. Thickness: 1/2-inch, minimum.
9. ANSI/BHMA: A156.21, J12100.
10. Products and Manufacturers: Provide one of the following:
    a. 171B by Pemko Manufacturing Company.
    b. Or equal.

O. Silencers:
1. Provide silencers for all door frames.
2. Provide pneumatic design that, once installed, forms an air pocket to reduce noise.
3. Provide minimum of three per strike side of door jambs.
4. ANSI/BHMA: A156.16, BHMA 6.5, L03011.
5. Products and Manufacturers: Provide one of the following:
    a. GJ 64 by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
    b. Or equal.

P. Wall and Floor Stops: Provide the following where scheduled in List of Door Hardware Items at end of Part 3:
1. Dome-Type Floor Stops:
    a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
    b. Coordinate height of dome-type floor mounted doors stops with threshold condition and undercut of door.
    c. Finish: US 26D satin chrome.
    d. ANSI/BHMA: A156.16, L12161.
    e. Products and Manufacturers: Provide one of the following:
        1) FB13/14R, FB17 by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
        2) Or equal.
2. Wall Stops:
    a. Cast bronze extra heavy-duty wall mounted door stop, one per leaf.
    b. Convex rubber bumper.
    c. ANSI/BHMA: A156.16, L12101.
    d. Products and Manufacturers: Provide one of the following:
        1) GJ 50C by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
        2) Or equal.

Q. Sealants: Provide elastomeric sealant complying with FS TT-S-00227, Type 2 (non-sag) Class A for use with thresholds.

2.3 HARDWARE FINISHES

A. Provide matching finishes for door hardware units at each door or opening, to the greatest extent possible in compliance with ANSI/BHMA A156.18.

B. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of door hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish for the latch and lock set for color and texture.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the substrate to receive door hardware, and the conditions under which the Work will be performed, and notify Engineer, in writing, of unsatisfactory conditions. Do not proceed with the door hardware Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

A. Templates: Furnish door hardware templates to each fabricator of doors, frames and other Work to be factory-prepared for the installation of door hardware. Check the Shop Drawings of such other Work, to confirm that adequate provisions are made for the proper installation of the door hardware.

B. Prepare Work to receive door hardware Work in compliance with ANSI/DHI A115.1.

3.3 INSTALLATION

A. Installer shall check and approve the installation before operation. Installer shall assure that the system operates to the Owner's satisfaction.

B. Mount door hardware units at heights recommended in, Door and Hardware Institute, “Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames” and “Recommended Locations for Builders’ Hardware for Custom Steel Doors and Frames", except as otherwise specified or required to comply with governing authorities having jurisdiction at the Site, HMMA 830 and ADAAG requirements.

C. Install each door hardware item in compliance with the manufacturer's instructions and recommendations and approved Shop Drawings. Wherever cutting and fitting is required to install door hardware onto or into surfaces that are later to be painted or finished in another way, install each item completely, then remove, and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.

D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

F. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel that will not corrode in contact with the threshold metal.

H. Set thresholds in a bead of elastomeric sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant before sealant cures to a firm set.

I. Adjust and check each operating item of door hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with the type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

J. Final Adjustment: Where door hardware installation is made more than one month prior to Substantial Completion, return to the Work during the week prior to acceptance or occupancy, and make a final check and adjustment of all door hardware items in each space and area. Clean and re-lubricate operating items as necessary to restore proper function and finish of door hardware and doors. Adjust door control devices to compensate for final operating of heating and ventilating equipment.

K. Provide manufacturer's authorized representative to instruct and train Owner's personnel in proper adjustment and maintenance of door hardware during the final adjustment of door hardware.

L. Door hardware, which is blemished or defective, will be rejected even though it was set in place before defects were discovered. Remove and replace with new door hardware. Repair all resultant damage to other Work.

M. Continued Maintenance Service: Approximately six months after the acceptance of door hardware in each area, the installer, accompanied by the representative of the latch and lock manufacturer, shall return to the Project and re-adjust every item of hardware to restore proper function of doors and door hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Clean and lubricate operational items wherever required. Replace door hardware items that have deteriorated or failed due to faulty design, materials or installation of door hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance or the door hardware.

3.4 FIELD QUALITY CONTROL

A. Provide a written field report, prepared by installer's architectural hardware consultant, identifying actual condition, location, manufacturer, and product designation for each item of door hardware actually present on each door at the Site, including whether door hardware is adjusted and operating properly, compared with each item referenced to approved Shop Drawings and Contract requirements.

B. Installer's hardware consultant shall provide opinions to, and assist Engineer in determining, acceptability of installation as Work proceeds. All comments and discussions, conversations and meetings with Engineer shall be included in written field report for submission to Engineer for review and approval at completion of door hardware installation.

C. As part of written field report to be submitted to Engineer for approval, recommend remedial actions for Work not in compliance with these Specifications. No payment for Work shall be made until remedial recommendations and actions have been approved by Engineer and incorporated into the Work.

3.5 LIST OF DOOR HARDWARE ITEMS

A. Scheduled items for each door are generic and rely on information specified above. The listing of hardware functions and types provided are only a general guideline for the final Door Hardware

Schedule. Contractor shall submit a Door Hardware Schedule acceptable to all governing authorities having jurisdiction at the Site.

B. Provide the following door hardware items:

1. Set 1: Doors: R101-1, R002-3, R003-3, R102-3, R102-4, R107-1, R108-1, R109-1

Qty	Description
3	Hinges
1	Closer
1	Panic Exit Device - Entrance
3	Silencers
1	Stops
1	Protection Armor
1	Threshold
1	Weatherstripping

2. Set 2: Doors: R002-1, R002-2, R003-1, R003-2, R101-2, R107-2, R108-2, R109-2, R110-2

Qty	Description
3	Hinges
1	Closer
1	Panic Exit Device – Passage
3	Silencers
1	Stops
1	Protection Armor

3. Set 3: Doors: R106-1

Qty	Description
3	Hinges
1	Closer
1	Panic Exit Device - Storage
3	Silencers
1	Stops
1	Protection Armor
1	Threshold
1	Weatherstripping

4. Set 4: Doors: R101-2

Qty	Description
3	Hinges
1	Closer
1	Lockset – Office
3	Silencers
1	Stops

5. Set 5: Doors: R104-1, R106-1

Qty	Description
3	Hinges
1	Closer
1	Lockset – Storage
3	Silencers

1	Stops

6. Set 6: Doors: R106-2

Qty	Description
6	Hinges
1	Closer – Active Door
1	Flush Bolt top and bottom (inactive door)
1	Lockset – Storage
3	Silencers
1	Stops
1	Threshold
1	Weatherstripping

7. Set 7: Doors: R103-1

Qty	Description
3	Hinges
1	Lockset – Privacy
3	Silencers
1	Stops

8. Set 8: Doors: R105-1

Qty	Description
6	Hinges
1	Closer – Active Door
1	Flush Bolt top and bottom (inactive door)
1	Lockset – Storage
3	Silencers
1	Stops

END OF SECTION 08 7100

SECTION 08 8100

GLASS GLAZING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install glass glazing.
   2. Extent of glass glazing is shown.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the glass glazing Work.
   2. Notify other contractors in advance of the installation of the glass glazing to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the glass glazing Work.

C. Related Sections:
   1. Section 07 9200, Joint Sealants.
   2. Section 08 1113, Hollow Metal Doors and Frames.
   3. Section 08 5113, Aluminum Windows.
   4. Section 08 6200, Unit Skylights.
   5. Section 10 2805, Toilet and Bath Accessories.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Architectural Manufacturers Association, (AAMA).
      a. AAMA 800, Voluntary Specifications and Test Methods for Sealants.
   2. American National Standards Institute, (ANSI).
      a. ANSI Z97.1, Safety Glazing Materials Used in Buildings.
      b. ANSI/ASTM E 774, Specification for Classification of the Durability of Sealed Insulating Glass Units.
      c. ANSI/ASTM E 1300, Practice for Determining Load Resistance of Glass in Buildings.
   3. American Society of Civil Engineers, (ASCE).
      a. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
   4. American Society for Testing and Materials, (ASTM).
      a. ASTM C 509, Specification for Elastomeric Cellular Performance Gasket and Sealing Material.
      b. ASTM C 719, Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement (Hockman Cycle).
      c. ASTM C 793, Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants.
      d. ASTM C 794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
      e. ASTM C 864, Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.

f. ASTM C 920, Specification for Elastomeric Joint Sealants.
g. ASTM C 1021, Practice for Laboratories Engaged in Testing of Building Sealants.
h. ASTM C 1036, Specification for Flat Glass.
i. ASTM C 1048, Specification for Heat-Treated Flat Glass-Kinds HS, Kind FT Coated and Uncoated Glass.
j. ASTM C 1087, Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
k. ASTM C 1115, Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
l. ASTM C 1172, Specification for Laminated Architectural Flat Glass.
m. ASTM C 1249, Guide for Secondary Seal for Sealed Insulating Glass Units for Structural Sealant Glazed Applications.
n. ASTM C 1281, Specification for Preformed Tape Sealants for Glazing Applications.
o. ASTM C 1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
p. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
q. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
r. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.
s. ASTM E 548, Guide for General Criteria Use for Evaluating Laboratory Competence.

5. Code of Federal Regulations, (CRF).
   a. 16 CFR, Consumer Product Safety Commission, CPSC Part 1201, Safety Standard for Architectural Glazing Materials.
6. Glass Association of North America, (GANA).
   a. GANA, Glazing Manual.
   b. GANA, Laminated Glass Design Guide.
   c. GANA, Glass Tempering Division, GTA 95-1-31, Specification for Decorative Architectural Flat Glass.
7. Lawrence Berkeley National Laboratory National Technical Information Service, (LBL).
   a. LBL-35298 Window 4.1, "A PC Program for Analyzing the Thermal Performance of Fenestration Products."
8. National Fire Protection Association, (NFPA).
   a. NFPA 80, Standard for Fire Doors and Fire Windows.
   b. NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
   c. NFPA 257, Standard on Fire Tests for Window and Glass Block Assemblies.
9. National Fenestration Rating Council, (NFRC).
   a. NFRC 100, Procedure for Determining Fenestration Product U-Factors.
   b. NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
   c. NFRC 300, Procedures for Determining Solar Optical Properties of Simple Fenestration Products.
10. National Glass Association, (NGA).
    a. NGA, Glazier Certification Program.
11. Primary Glass Manufacturers Council, (PGMC).
    a. PGMC Specifiers' Guide to Architectural Glass.
12. Sealed Insulating Glass Manufacturers Association, (SIGMA).
    a. SIGMA TM-3000-90, Vertical Glazing Guidelines and TB-3001-90, Sloped Glazing Guidelines.
13. Underwriters' Laboratories, Inc., (UL).

a. UL Building Materials Directory.

1.3 QUALITY ASSURANCE

A. Primary Glass Manufacturer and Glazing Materials Manufacturer Qualifications:
   1. Provide glass glazing materials manufactured by firms specializing in the production of the types of glass glazing products specified, in compliance with specified standards.
   2. Provide glass from manufacturers who are members of GANA and PGMC and participate in certification programs.
   3. Obtain glass glazing materials from manufacturers who will send a qualified technical representative to the Site, for the purpose of advising the installer of proper procedures and precautions for the use of the materials and who will assist Engineer with opinions on the acceptability of materials and Work.

B. Fabricator Qualifications:
   1. Provide laminated and insulating glass fabrications from fabricators who are licensed by primary glass manufacturer to produce specified units and with documented skill and successful experience in this type of Work and who agree to employ only tradesmen who are trained, skilled and have successful experience in this type of Work.
   2. Provide laminated and insulating glass fabrications from fabricators who are members of GANA or SIGMA and participate in certification programs.
   3. Obtain laminated and insulating glass fabrications from fabricators who will, if required, send a qualified technical representative to the Site, for the purpose of assisting Engineer with opinions on the acceptability of materials and installation methods.

C. Installer's Qualifications:
   1. The installer of the glass glazing materials shall be a firm with documented skill and successful experience in the installation of the types of materials required and who agrees to employee only tradesmen who are trained, skilled and have successful experience in the types of materials and glazing systems specified and who are certified under the National Glass Association Glazier Certification Program as Level 3 (Master Glaziers).
   2. Submit records of experience and certifications to Engineer.

D. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing specified, as documented according to ASTM E 548.

E. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct testing specified, as documented according to ASTM E 548.

F. Source Limitation: All materials provided under this Section shall be obtained from a single supplier or manufacturer who, with Contractor, shall assume full responsibility for the completeness of the Work. The supplier or manufacturer shall be the source of information on all material furnished regardless of the manufacturing source of that material.

G. Regulatory Requirements:
   1. Wherever a fire-resistance-rating classification is shown or scheduled for doors or windows, (1-hour, 2-hour, 3-hour), provide glass complying with the requirements specified and established by UL, NFPA and other governing authorities having jurisdiction at the Site.
   2. Safety Glass: Comply with ANSI Z97.1, with label on each piece of glass as required by governing authorities having jurisdiction.

H. Codes: Comply with applicable requirements of codes referenced in Section 01 4100, Regulatory Requirements.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Plans and elevations showing location of each type and kind of glass specified and details of glazing system. Include manufacturer's recommendations for glazing.
      b. Dimensions and details of manufacturer's glue line thickness and bite dimensions and verifications.
   2. Product Data:
      a. Copies of manufacturers' specifications, "Spec-Data" sheets, installation instructions for each type of glass, glazing sealant or compound, gasket and associated miscellaneous material and all recommended installation precautions for required materials and components, which are not included in other submittals, specified in other Sections. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.
      b. Structural performance calculations indicating that detailing and fabrication have been based on the results of the required analysis and performance criteria specified.
   3. Delegated Design Submittals:
      a. Structural silicone sealant performance features and calculations indicating sealant joints have been detailed and fabricated in compliance with silicone sealant manufacturer’s recommended guidelines for dissimilar metal adhesion. Structural and other performance calculations for the structural silicone joints shall be prepared, signed and stamped with the seal of a Registered Professional Engineer, licensed to practice in the State of Ohio, and recognized as an expert in the required Work.
   4. Samples:
      a. 12-inch square samples of each type of glass required.
      b. Insulating glass samples need not be hermetically sealed, but edge construction, wavelength-selective interlayer and low-E coatings shall be included and identified. Include specially prepared samples with each interlayer film product's identity marked on film and incorporated into sample.
      c. Submit 12-inch long samples of each color for each type of exposed-to-view glazing sealant and gasket. Install sample between two strips of material similar to, or representative of, channel surfaces where sealant or gasket will be used, held apart to represent typical joint widths.
      d. Review of samples by Engineer will be for color, texture and pattern only. Compliance with other requirements is the responsibility of Contractor.

B. Submittals: Submit the following:
   1. Certificates:
      a. Low-E glass fabricator shall provide a letter of compliance verifying performance characteristics of each glass unit.
      b. Certification that all glass materials subject to the applicable standards of the CPSC are in compliance. The certification shall be issued in conformance with procedures stated in the standard.
      c. Include primary glass manufacturer's and fabricator’s published data, and letters of certification, based on certified test laboratory reports, indicating that each material complies with specified requirements and is acceptable for the applications shown.

d. Certification that fabricated products comply with manufacturer's published performance.
e. Age of silicone sealant.

2. Test Reports:
   a. Certified laboratory test reports for required performance tests in compliance with ASTM E 548.
   b. Provide wavelength-selective insulating glass or low-E glass manufacturer's computer-aided sheet engineering analysis to determine deflection and rabbet depth for individual applications, specified loadings, performance requirements, support criteria and other parameters, in order to indicate compliance with these Specifications.
   c. Wavelength-selective polyester film insulating glass or low-E glass fabricator's computer performance analysis of each glass configuration including argon filled interlayers for insulating glass units.
   d. Adhesion and compatibility test report from glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glazing channel substrates and for compatibility with glass and other glazing material.
   e. Performance analysis of each configuration of insulating glass incorporating wavelength selective interlayer or low E coating using LBL-35-298, Window 4.1.
3. Qualifications Statements:
   a. Fabricator.
   b. Installer.

1.5 Closeout Submittals: Submit the following:
1. Warranty Documentation:
   a. Manufacturer's and fabricator's guarantees, as specified.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Protect glass glazing materials according to manufacturer's and fabricator's written instructions to prevent damage to glass glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
3. For insulating glass that will be exposed to substantial altitude changes, comply with insulating glass fabricator's written recommendations for venting and sealing to avoid hermetic seal ruptures.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.7 SPECIAL WARRANTIES

A. General: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents.

B. Special Warranties:
   1. Laminated Glass: Provide written warranty, signed by the fabricator and Contractor and running to benefit of Owner, agreeing to replace, for a period of five-years from the date of Substantial Completion, glass units that show deterioration, as specified.
   2. Insulating Glass: Provide written warranty, signed by the fabricator and Contractor and running to the benefit of Owner, agreeing to replace, for a period of ten-years from the date of Substantial Completion, glass that shows signs of deterioration, as specified.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria: For glass performance, manufacture, size, type, construction and thickness, comply with the following:
   1. Provide glass glazing systems capable of withstanding normal thermal movements and wind and impact loads without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants (both structural and weather-resisting) to remain watertight, airtight and to maintain structural performance characteristics specified; deterioration of glazing materials; or other defects in construction.
   2. Normal Thermal Movement: Provide glass that allows for thermal movements resulting from a maximum temperature range of 120°F in ambient and 180°F surface temperature acting on glass framing members and glazing components. Base structural performance calculations on surface temperatures of materials caused by both solar heat gain and nighttime-sky loss.
   3. Comply with requirements of Consumer Product Safety Commission, Part 1201, Safety Standards for Architectural Glazing Materials, for all the Work.
   4. Structural Performance: Provide structural calculations for analysis of required glass thicknesses for glass lites shown, that are used to establish final fabricating and detailing requirements. Indicate compliance with the following minimum criteria for all glass shown:
      a. Project Wind Speed: 70 miles per hour based on ASCE 7 and the other governing authorities having jurisdiction at the Site.
      b. Importance Factor: Category 1; Iw = 1.15; Design Factor: 1.15.
      c. Exposure Category: Exposure C; Ce = 1.13.
      d. Wind Stagnation Pressure: qs = 12.6 psf.
      e. Long-Duration Loading: One month.
      f. Short-Duration Loading: Sixty seconds, based on three-second gust speed.
      g. Probability of Breakage for Vertical Glazing: Eight lites per 1,000 under wind action.
      h. Maximum Lateral Deflection: For glass supported on all four edges, provide thickness required to limit center deflection at design wind pressure to 1/50 times the short side length or 1-inch, whichever is less.
   5. Glass thicknesses shown are minimums. Confirm glass thicknesses by analyzing Project structural loadings and in-service conditions using glass manufacturer's recommended load tables and other structural performance criteria specified. Where manufacturer’s load tables

indicate acceptability of lesser thickness material than required by performance criteria specified, provide specified thicknesses and features as a minimum. Where load tables indicate the need for greater thickness, or additional features, than specified, provide greater thicknesses and features at no additional cost to Owner. Comply with practice for determining minimum thickness and types of glass, to resist loadings required by governing authorities having jurisdiction at the Site, according to ANSI/ASTM E 1300.

6. Provide each configuration of insulating glass incorporating low-E coatings.
7. Glazing Sealant System Compatibility:
   a. Glazing sealants shall be compatible with the channel surfaces, joint fillers, insulating glass sealing system, laminated glass interlayer material and other materials in contact with the glazing channel in compliance with ASTM C 1087.
   b. Provide only materials and manufacturer's recommended variation of the specified materials, which are known to be fully compatible with the actual installation conditions, as shown by manufacturer's published data or certification submitted to Engineer for approval.
8. Adhesion of Elastomeric Joint Sealants: Comply with ASTM C 793 and ASTM C 794.
9. Center-of-Glass U-Values: NFRC 100 methodology using LBL-35298 WINDOW 4.1 computer-aided software design, expressed as Btu/square foot by height by degree F.
10. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer-aided software design.
11. Solar Optical Properties: NFRC 300.

B. Definitions:
1. Interspace: The space between lites of an insulating glass unit that contains dehydrated air or a specified gas.
2. Deterioration of Coated Glass: Defects that develop from normal use, that are attributed to the manufacturing process, and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer’s written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
3. Deterioration of Laminated Glass: Defects that develop from normal use, that are attributed to the manufacturing process, and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer’s written instructions. Defects include edge separation, delamination materially obstructing vision through glass or structural performance or safety of units; blemishes exceeding those allowed by specified laminated glass standards; and cracking, crazing or color change of films concealed in the lamination.
4. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use that is attributed to the fabricating process or incompatibility of sealants or mishandling during installation, and not to causes other than glass breakage and practices for maintaining and cleaning glass contrary to manufacturer’s written instructions. Evidence of failure shall include the obstruction of vision by dust, moisture, or film on interior surfaces of insulating glass.

2.2 GLASS

A. Clear, Float Glass:
1. Uncoated, Monolithic, Clear, Float Glass: Provide clear glass in compliance with ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality q^3 (glazing select); 1/4-inch thick, minimum.
2. Products and Manufacturers: Provide one of the following:
   a. Clear Float Glass by PPG Industries, Incorporated.

b. Clear Float Glass by Pilkington Libbey-Owens-Ford Company.
c. Or equal.

B. Clear, Fully Tempered, Float Glass:
1. Uncoated, Monolithic, Clear, Fully Tempered, Float Glass: Provide clear glass, with roll-wave distortion parallel to bottom edge of glass, in compliance with ASTM C 1048, Type I (transparent glass, flat), Class 1 (clear), Quality q^3 (glazing select), Kind FT.
2. Provide heat-strengthened glass that has been heat-strengthened by manufacturer's special process (after cutting to final size,) to achieve a flexural strength of up to five times that of annealed glass strength; 1/4-inch thick, minimum.
3. Products and Manufacturers: Provide one of the following:
a. Herculite Clear by PPG Industries, Incorporated.
b. Fully Tempered Clear Glass by Guardian Industries, Corporation.
c. Or equal.

C. Clear, Pyrolytic-Coated, Float Glass:
1. Coated, Monolithic, Clear, Float Glass: Provide clear float glass with solar-reflective metallic-oxide coating applied by pyrolytic deposition during initial manufacture in compliance with ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality q^3 (glazing select); 1/4-inch thick, minimum.
2. Physical Properties:
a. Tint Color: Clear.
b. Visible Light Transmittance: 69 to 82 percent.
c. Solar Heat Gain Coefficient: 0.37 to 0.69.
d. Outdoor Visible Light Reflectance: Ten to twelve percent.
e. Shading Coefficient: 0.44 to 0.81.
3. Products and Manufacturers: Provide one of the following:
a. Sungate 1000 Low-E Clear Float Glass by PPG Industries, Incorporated.
b. Energy Advantage Low-E Clear Float Glass by Pilkington Libbey-Owens- Ford Company.
c. Or equal.

D. Clear, Insulating, Float Glass Units:
1. Uncoated, Monolithic, Clear, Float Glass: Provide clear glass in compliance with ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality q^3 (glazing select).
2. Insulating Glass Units: Provide preassembled units consisting of two lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class C units, permanently and hermetically sealed together at edges with spacers and sealant.
3. System Sealing: Dual seal with polyisobutylene primary sealant and silicone secondary sealant, complying with ASTM C 1249.
4. Overall Unit Thickness and Thickness of Each Lite:
a. Overall Thickness: 1-inch.
b. Each Lite: 1/4-inch.
5. Physical Properties:
a. Exterior Appearance: Clear.
b. Visible Light Transmittance: 78 percent, minimum.
c. Solar Heat Gain Coefficient: 0.70.
d. Outdoor Visible Light Reflectance: 15 percent.
e. Shading Coefficient: 0.81.
f. Winter Nighttime U-value: 0.48.
g. Summer Daytime U-value: 0.55.

6. Products and Manufacturers: Provide one of the following:
    a. Clear Twindow by PPG Industries, Incorporated.
    b. Clear Thermopane by Pilkington Libbey-Owens-Ford Company.
    c. Or equal.

2.3 GLAZING SEALANTS, TAPES AND GASKETS

A. General:
1. Colors: Provide black or other natural color wherever no other color is available. Wherever material is not exposed-to-view, provide manufacturer's standard color, which has the best overall performance characteristics for the application shown.
    a. Provide manufacturer's standard colors as shown or, if not shown, provide color selected by Engineer from manufacturer's standard colors to either blend or contrast with adjoining surfaces.
    b. Provide custom colors, as selected by Engineer.
2. Hardness specified is intended to indicate the general range necessary for overall performance. Submit glazing and sealant manufacturer’s recommendations for actual hardness for each condition of installation and use. Except as shown or specified, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75°F):
    a. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 united inches). Provide material sufficiently hard to withstand exposure to abrasion and vandalism.
    b. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 united inches). Provide materials sufficiently hard to withstand impact of moving sash and doors.
    c. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for application or insertion of units.
    d. 75 to 80 for structural gaskets (not supported by stops).
    e. Non-Elastomeric Compounds: (Shore A not applicable) 2 to 12 mm penetration for 5.0 seconds of penetrometer needle on nominally cured compound, complying with ASTM D 2451.
3. Provide size and shape of gaskets and preformed glazing units as recommended by the manufacturer and as indicated on approved Shop Drawings.
4. Comply with ASTM C 920 and other requirements for each liquid-applied, chemically curing sealant specified.
5. Where additional movement capability is specified, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement, in compliance with ASTM C 719, to withstand the specified percentage change in the joint width existing at the time of installation and remain in compliance with other requirements in ASTM C 920 for uses shown.

B. Preformed Butyl Rubber Back-Bedding Mastic Glazing Tape:
1. Preformed tape of polymerized butyl or mixture of butyl and polyisobutylene with inert fillers with built-in spacer of synthetic rubber, solvent-based with minimum 95 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, complying with AAMA 806.3.
2. Products and Manufacturers: Provide one of the following:
    a. Polyshim II Glazing Tape by Tremco, Incorporated.
    b. Or equal.

C. Dense Compression Wedge Gaskets:

1. Provide molded or extruded, closed-cell silicone wedge gaskets in compliance with ASTM C 1115, Type C.
2. Products and Manufacturers: Provide one of the following:
    a. Dense Silicone Wedge Gaskets SCR-900 by Tremco, Incorporated.
    b. Or equal.

D. Exterior, One-Part, Silicone Rubber Sealant:
1. Silicone rubber-based, one-part elastomeric sealant, complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, G, A and O.
2. Products and Manufacturers: Provide one of the following:
    a. Spectrem I by Tremco, Incorporated.
    b. 863 Architectural Silicone Sealant by Pecora Corporation.
    c. Or equal.

E. Structural Silicone Sealant:
1. Provide a one-component, self-priming, shelf-stable, neutral-cure, elastomeric adhesive complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, G and A, and specifically formulated for silicone structural glazing complying with the following as-cured physical properties, after seven days at 77°F and 50 percent relative humidity:
2. Durometer Hardness, Shore A, points; ASTM D 2240: 27 to 40.
3. Ultimate Tensile, ASTM D 412: 225 to 350 psi.
4. Ultimate Elongation, ASTM D 412: 525 to 550 percent.
5. Tear Strength, Die B; ASTM D 624: 40 to 49 ppi.
6. Peel Strength, ASTM C 794: 30 to 40 ppi.
7. Products and Manufacturers: Provide one of the following:
    a. DOW CORNING 995 Silicone Structural Adhesive by Dow Corning Corporation.
    b. 895 Silicone by Pecora Corporation.
    c. Or equal.

2.4 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standards, requirements of manufacturers of glass glazing materials for applications shown, and approved Shop Drawings. Provide materials with a proven record of compatibility with surfaces shown and specified.

B. Setting Blocks: Elastomeric material, 80 to 90 Shore A durometer hardness, with proven compatibility with sealants used in the Work and as recommended by the glass manufacturer.

C. Spacers and Edge Blocks: Elastomeric blocks or continuous extrusions, with a Shore A durometer hardness recommended by glass manufacturer to maintain lites in place and to limit lateral movement for installation shown, and with proven compatibility with sealants used in the Work.

D. Cylindrical Glazing Sealant Backing: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam complying with ASTM C 1330, Type O (open-cell material), proven to be compatible with sealants used, flexible and resilient, with 5 to 10 psi compression strength for 25 percent deflection.

E. Cleaners, Primers and Sealers: Type recommended by sealant, gasket and glass manufacturer.

2.5 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Glass manufacturer's recommended glazing channel dimensions are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. Contractor shall be responsible for correct glass size for each opening, within the tolerances and necessary dimensions established on approved Shop Drawings.

2.6 TOLERANCES

A. Allowable Tolerances: Provide fully tempered and heat-strengthened glass, formed by horizontal roller-hearth process, free of tong marks, and not exceeding the following flatness tolerances (either face, any direction, any location) based on 1/4-inch glass thickness with inversely proportionate tolerances for other thicknesses:
   1. For 12-inch Run: 1/16-inch bow.
   2. For 3-foot Run: 1/8-inch bow.
   3. For 7-foot Run: 1/4-inch bow.
   4. For 10-foot Run: 3/8-inch bow.

2.7 SOURCE QUALITY CONTROL

A. To the greatest extent possible, provide each type of glass glazing materials from one manufacturer.

B. Providing insulating glass with a certified Class A rating according to SIGMA.

C. Obtain glass and sealant test results for product test reports from qualified testing agencies regularly engaged in the business of testing glass and sealant products.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glass glazing is to be performed, and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings, which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

B. Apply primer or sealer to joint surfaces wherever recommended by sealant and glass manufacturer.

3.3 INSTALLATION

A. General:
   1. Comply with combined recommendations of glass, window and glazing products manufacturers and other materials used in glazing, except where more stringent requirements are shown or specified, and as shown on approved Shop Drawings.

2. Comply with GANA, Glazing Manual, except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass glazing materials, as accepted by Engineer on approved Shop Drawings.
3. Inspect each piece of glass immediately before installation, and remove from Site all that have observable edge damage or face imperfections.
4. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.
5. Cut and install tinted and reflective glass as recommended in manufacturer's technical bulletin as provided on approved Shop Drawings.
6. Install sealants as recommended by sealant manufacturers, and as recommended on approved Shop Drawings.
7. Do not attempt to cut, seam, nip or abrade glass on Site, which is tempered, heat strengthened, or coated.
8. Do not proceed with installation of liquid glazing sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
9. Proceed with glazing only when forecasted weather conditions are favorable to proper cure and development of high early bond strength. Wherever channel action is affected by ambient temperature variations, install glazing sealants only when temperatures are in the middle third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation or compression, and bond stress will not be excessive at extremely low or high temperatures.
10. Coordinate the installation of the glass glazing Work with the Progress Schedule in order to avoid delay of Project.

B. Tape and Sealant Glazing:
1. Place setting blocks in sill rabbets, sized and located to comply with referenced glazing publications. Set blocks in thin course of compatible sealant for heel bead. Position glass on setting blocks and press against tape for full contact.
2. Provide spacers for glass lites where the length plus width is larger than 4 foot-2 inches. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
3. Provide 1/8-inch minimum bite for spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
4. Provide edge spacers are shown on approved Shop Drawings and as required to prevent glass lites from moving sideways in glazing channel.
5. Cut glazing tape to length and set against permanent stops. Install horizontal strips first, extending over width of opening, before applying vertical strips.
6. Remove paper backing from tape. Place glazing tape on free perimeter of glass. Install tapes continuously. Do not stretch tape to make them fit openings. Place joints in tapes at corners of openings with adjoining lengths butted together, not lapped. Seal butt joints of tape with joint sealant.
7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
8. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact. Position tapes on fixed stops so that, when compressed by glass, their

exposed edges are flush with or protrude slightly above sightline of stops. Calk space above glazing tape to top of glazing stop. Tool exposed surfaces of sealant compounds to provide a substantial "wash" away from the glass.

9. Clean and trim excess glazing materials from the installation, and eliminate stains and discolorations.
10. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended on approved Shop Drawings and to prevent corners from pulling away; seal corner joints and butt joints with sealant as recommended by gasket manufacturer and as shown on approved Shop Drawings.

C. Dry Gasket Glazing: Install glass in gaskets as recommended by the glass and window manufacturer. Refer to Section 08 1113, Hollow Metal Doors and Frames, Section 08 5113, Aluminum Windows.

D. Skylight Glazing: Refer to Section 08 6200, Unit Skylights.

E. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

F. The installer shall advise Contractor of procedures required for the protection of glass glazing sealants and compounds during the construction period, so that they will be without deterioration or damage, other than normal weathering, at the time of Substantial Completion.

G. Furnish specific instructions on the precautions and provisions required to prevent glass damage resulting from the alkaline wash from concrete surfaces and similar sources of possible damage.

H. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.

I. Remove and replace glass, which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.

J. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other work.

K. Remove non-permanent labels and wash and polish glass on both faces not more than four days prior to Substantial Completion. Comply with glass manufacturer's recommendations for cleaning.

3.4 FIELD QUALITY CONTROL

A. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for

operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the Work.

B. After nominal cure of exterior glazing sealants, which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch hose held perpendicular to wall face, 2 foot-0 inches from joint, connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 foot-0 inches per minute.

C. Test approximately five percent of total glazing system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct tests in the presence of Engineer, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

D. Repair glazing installation at leaks or, if leakage is excessive, replace glazing sealants as directed by Engineer.

E. Wherever nature of observed leakage indicates the possibility of inadequate glazing joint bond strength, Engineer may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme temperatures, and returned to the range of temperature in which it is feasible to conduct testing. Repair or replace Work as required and directed by the Engineer.

END OF SECTION 08 8100

SECTION 08 9000

LOUVERS AND VENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all louvers and vents Work.
   2. Extent of louvers and vents Work is shown.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the louvers and vents Work.
   2. Verify size, location and placement of louver and vents prior to fabrication, wherever possible. Coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in as large sections as practicable.

C. Related Sections:
   1. Section 07 9200, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM B 117, Practice for Operating Salt Spray Apparatus.
      b. ASTM D 522, Test Methods for Mandrel Bond Test of Attached Organic Coatings.
      c. ASTM D 523, Test Method for Specular Gloss.
      d. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
      e. ASTM D 2244, Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
      f. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
      g. ASTM D 3363, Test Method for Film Hardness by Pencil Test.
      h. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.

1.3 QUALITY ASSURANCE

A. Performance Criteria: Comply with Sheet Metal and Air Conditioning Contractor's National Association, Architectural Sheet Metal Manual, recommendations for fabrication, construction details, and installation procedures, except as otherwise shown on the Drawings or specified.

B. Component Supply and Compatibility:
   1. Obtain each separate type of louver and vents from a single supplier and from a single manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following
   1. Shop Drawings:
      a. Include plans, elevations, sections, details and attachments to other work. Show blade profiles, angles and spacing.
   2. Product Data:
      a. Copies of manufacturer's material specifications, recommended written installation instructions and manufacturer's specifications showing
   3. Delegated Design Submittals:
      a. For installed louvers and vents indicated to comply with design loads, include structural analysis data signed and sealed by a Registered Professional Engineer licensed in the State of Ohio, who is responsible for their preparation.
   4. Samples: For units with factory-applied color finishes.
      a. Cut-a-way samples of corner section of each type of louver made from 12-inch lengths of full size components and showing the proposed details of joinery, anchorage, movement, glazing, flashing and drainage and with specified finish, prior to fabrication of the Work.
   5. ENGINEER reserves the right to require samples demonstrating design, detailing and fabrication techniques and workmanship for each auxiliary louver component and accessory, before fabrication proceeds.
      a. Provide anodized finish manufacturer's complete color charts.
      b. One of each type fastener employed, with statement of intended use.
      c. Samples will be reviewed by Engineer for materials, fabrication techniques, proposed system components, workmanship and color. Compliance with other requirements is the responsibility of Contractor.

B. Informational Submittals: Submit the following:
   1. Source Quality Control Submittals:
      a. Comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 WARRANTY

A. Provide written warranty agreeing to replace louver and vent Work which fails in materials or workmanship within three years of the date of Final Acceptance. Failure of materials or workmanship shall include, but is not limited to, excessive leakage or air infiltration, excessive deflections, deterioration of finish or metal in excess of normal weathering, and defects in accessories, weatherstripping, and other components of the Work.

B. The warranty does not apply where failure is caused by accidents, or external conditions or forces beyond the control of the manufacturer.

PART 2 - PRODUCTS

2.1 LOUVER AND VENTS PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide louvers and vents capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.
   1. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq.ft., acting inward or outward.

B. Seismic Performance: Provide louvers capable of withstanding the effects of earthquake motions determined according to the Ohio Building Code and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads".
   1. Seismic Design Criteria: Refer to contract drawings.

C. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 20°F, ambient; 120°F, material surfaces.

2.2 MATERIALS

A. Aluminum Sheet: ASTM B 209, Alloy 5005 with temper as required for forming or as otherwise recommended by the metal producer to provide the required finish.

B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T52.

C. Fastenings: Use same material as items fabricated. Provide types, gages and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise specified. Use continuous aluminum closure angles on the inside perimeter frame of all louver and vents Work, finished to match louvers and vents.

D. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to four times the loads imposed, for concrete, or six times the loads imposed, for masonry, as determined by testing conforming to ASTM E 488, conducted by a qualified independent testing agency.

E. Protection of aluminum from dissimilar materials shall conform to Section 09 9100, Painting.

2.3 FABRICATION, GENERAL

A. Assemble louvers and vents in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver and vent units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
   1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern, unless horizontal mullions are shown.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes as shown, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   1. Frame Type: Channel, unless otherwise shown and as specified.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacing shown, but not more than recommended by manufacturer, or 72-inches on centers, whichever is less.
   1. Fully Recessed Mullions: Where shown, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
   2. Exposed Mullions: Where shown, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.

G. Where shown, provide subsills made of same material as louvers.

H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise shown or size of louver assembly makes bolted connections between frame members necessary.

2.4 FIXED, EXTRUDED ALUMINUM LOUVERS

A. Furnish 6-inch fixed louvers where shown, or scheduled. Drainable blades shall incorporate a front lip gutter and recessed second gutter, both of which direct water to jamb and mullion drains.

B. Free Area Velocity: Maximum 960 feet per minute free area velocity at a pressure drop of not more than 0.17-inches water gage carrying less than 0.01 ounces of water per square foot of free area.

C. All blades shall be 0.081-inch thick. Provide all blades with integral drainage trough along edge of blades. Frame shall be 0.125-inches thick. Mullions shall be of the sliding interlock type.

D. Free Area: Not less than 7.3 square feet for a 48-inch by 48-inch high louver.

E. Provide louver supports designed to carry 30 pounds per square foot wind load.

F. Install gravity backdraft damper and louver screen behind the louver.

G. Products and Manufacturers: Provide one of the following:

1. No. A6177 by Construction Specialties, Incorporated.
2. No. K6776 by the Airolite Company .
3. Or equal.

2.5 FINISHES

A. Anodized Finish:
1. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018-mm or thicker) complying with AAMA 611.

2.6 LOUVER SCREENS

A. Provide removable screens for all louvers.

B. Fabricate screen frames of the same metal and finish as the louver units to which secured. Provide frames consisting of extra heavy duty extruded 0.090-inch aluminum for permanently securing screen mesh. Frames shall be rewirable.

C. Provide insect screen of 18 by 14 mesh, 0.0123-inch diameter stainless steel intercrimp wire. 0.063-inch diameter stainless steel intercrimp wire for all other louvers.

D. Provide bird screen, 1/2-inch square stainless steel wire, 0.063-inch diameter wire.

E. Locate screens on inside face of louvers. Secure screens to louver frames with machine screws, spaced at each corner and at 12-inches on centers.

F. Provide minimum No. 8 stainless steel metal screws, unless larger screws are required by screen size.

G. Provide cross bar screen reinforcement of same material and finish as louver which subdivides screens into maximum area of 50 square feet.

2.7 SILL EXTENSION

A. Gage and Finish: Same as louver.

2.8 ATTACHMENT FRAME

A. Gage and Finish: Same as louver.

B. Size: As shown on the Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and his installer must examine the areas and conditions under which louvers and vents Work and associated items are to be installed and notify Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the Site.

3.3 INSTALLATION

A. Locate and place louver units plumb, level and in proper alignment with adjacent work.

B. Use stainless steel expansion bolt anchors with stainless steel washers and neoprene gaskets. Use spring clips at all anchors to stop deflection of the louver frame. Provide anchors spaced 2 feet-0 inches on centers. Provide continuous aluminum angles for anchoring all operable louvers.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as shown.

D. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective Work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, as determined by Engineer.

E. Protection of Aluminum from Dissimilar Materials: Coat all aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09 9100, Painting.

3.4 FIELD QUALITY CONTROL

A. Determine conformity of louver polyvinylidene fluoride finish to these Specifications, as follows:
   1. The manufacturer of the louver and vents shall set aside and label samples of the metal from each production lot for the job. Protect samples from weather.
   2. Make sample louver and vent available at all times, for comparison with installed louver and vent Work as requested by Owner, for the full time of the warranty.
   3. Make color comparison measurements with a Hunter Tristimulus Color Difference Meter employing methods of computation in use at the National Bureau of Standards conforming to ASTM D 2224.

3.5 ADJUSTMENT AND CLEANING

A. Set adjustable louver blades for uniform alignment in open and closed positions.

B. Adjust louvers so moving parts operate smoothly.

C. Louvers with dents, warps, gouges or scratches shall be replaced with new louvers, at no additional cost to Owner.

END OF SECTION 08 9000

SECTION 09 5113

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install acoustical panel ceilings. The Work also includes:
      a. Providing openings in acoustical panel ceilings to accommodate the Work under this and other Sections and building into the acoustical panel ceilings all items to be embedded in, or penetrate, acoustical panel ceilings.
   2. Extent of acoustical panel ceilings is shown.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the acoustical panel ceilings Work.
   2. Coordinate furnishing and installing products for maintaining the fire-resistance-rating of ceiling construction at perimeters and penetrations where built-in and recessed items and transitions with other building components occur in the acoustical panel ceilings Work.

C. Related Sections:
   1. Section 07 2105, Building Insulation.
   2. Section 07 9200, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM A 153/A 153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. ASTM A 366/A 366M, Specification for Commercial Steel Sheet, Carbon, (0.15 maximum percent) Cold-Rolled.
      c. ASTM A 510, Specification for General Requirements for Wire Rods and Coarse Round Wire,
      d. ASTM A 641/A 641M, Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
      e. ASTM B 221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      f. ASTM C 423, Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      g. ASTM C 635, Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
      h. ASTM C 636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
      i. ASTM C 834, Specification for Latex Sealants.
      j. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.

k. ASTM E 119, Test Methods for Fire Tests of Building Construction and Materials.
l. ASTM E 413, Classification for Rating Sound Insulation.
m. ASTM E 488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
n. ASTM E 580, Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Seismic Restraint.
o. ASTM E 795, Practice for Mounting Test Specimens During Sound Absorption Tests.
p. ASTM E 1264, Classification for Acoustical Ceiling Products.
q. ASTM E 1414, Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
r. ASTM E 1477, Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
s. ASTM F 593, Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
t. ASTM F 594, Specification for Stainless Steel Nuts.

2. Architectural Metal Products Division of the National Association of Architectural Metal Manufacturers, (AMP).
   a. AMP, 501, Finishes for Aluminum.
3. Ceiling and Interior Systems Construction Association, (CISCA).
   a. CISCA, Acoustical Ceilings: Use and Practice.
   b. CISCA, Ceiling Systems Handbook.
4. Underwriters' Laboratories, Inc., (UL).
   a. UL, Fire Resistance Directory.

1.3 QUALITY ASSURANCE

A. Installer's Qualifications:
1. Engage a single installer regularly performing installation of acoustical panel ceilings with documented skill and successful experience in the installation of the types of materials required; and who agrees to employee only tradesmen who are trained, skilled and have successful experience in installing the types of materials specified.
2. Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
   a. Names and telephone numbers of owners, architects or engineers responsible for projects.
   b. Approximate contract cost of the acoustical panel ceilings.
   c. Amount of area installed.

B. Testing Agency Qualifications: The independent testing agency shall demonstrate to Engineer’s satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work. Submit name and qualifications to Engineer.

C. Source Quality Control:
1. Furnish all components of each acoustical panel ceiling system from a single manufacturer and from a single supplier with adequate resources to provide products of consistent performance characteristics, physical properties and appearance, without delaying the Work.

D. Mock-Ups:

1. Before proceeding with final purchase of materials and installation of acoustical panel ceiling systems, but after Engineer's acceptance of Samples and Shop Drawings, install 100 square foot samples of each type of acoustical panel ceiling system, including all accessory trim, insulation specified in Section 07 2105, Building Insulation, control and expansion joints specified in Section 07 9513, Expansion Joint Cover Assemblies, built-in items that may be specified in other Sections, indicating the final relationship and configurations of the various parts and components and the quality of workmanship that shall be achieved in the Work. Locate mock-ups in areas selected by Engineer to show a representative installation of each type of acoustical panel ceiling system.
2. Incorporate materials and methods of installation that are identical to Project requirements.
3. Obtain Engineer's acceptance of visual qualities of mock-up before start of acoustical panel ceiling Work. Retain and protect mock-up during construction as a standard for judging completed acoustical panel ceiling. Do not alter or remove approved mock-ups.
4. Build as many mock-ups as required to obtain Engineer's acceptance. Disassemble rejected mock-ups and remove all components from Site. Do not incorporate rejected mock-up components into the Work. Accepted mock-up may be incorporated into the finished Work.
5. Acoustical panel ceiling Work that proceeds without approved mock-ups shall be stopped, and mock-ups prepared for Engineer's acceptance.
6. Acoustical panel ceilings that do not meet the standard of workmanship on the accepted mock-up shall be removed and replaced with new material.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Copies of manufacturer's product specifications and installation instructions for each acoustical ceiling material required, and for each suspension system. Include certified laboratory test reports and other data as required to show compliance with these Specifications.
      b. Include manufacturer's recommendations for cleaning and refinishing acoustical units, including precautions against materials and methods, which may be detrimental to finishes and acoustical performances.
   2. Reflected ceiling plans of suspension systems, showing hanger, anchor and acoustical panel locations, drawn to a scale of 1/4-inch equal to 1 foot-0 inch, and details of all transitions of acoustical panels with other items such as light fixtures, air diffusers, and perimeter walls and all supporting and suspension system details, including method of attachment of suspension system hangers to building structure, drawn to a scale of 3/4-inches equal to 1 foot-0 inches.
      a. Show and coordinate locations of ceiling-mounted items, automatic fire suppression system sprinkler heads, speakers, and penetrations for other items of Work that are to be coordinated with the ceiling, and show framing and support details for Work supported by the suspension system.
      b. Complete information on all anchors and supports indicating maximum resistance to tension, in compliance with performance criteria specified.
   3. Samples:
      a. Full size samples for each acoustical panel specified. Samples shall show the full range of exposed color and texture to be expected in the completed Work.
      b. 12-inch long samples of each exposed runner and molding.
      c. Engineer's review will be for color and texture only. Compliance with other requirements is the responsibility of Contractor.

B. Informational Submittals: Submit the following:
   1. Test Reports:
      a. Certify compliance with ASTM C 635 and other specified requirements, and indicate structural classification of each type of suspension system.
      b. Evidence of acoustical panel ceiling system's compliance with requirements of governing authorities having jurisdiction at the Site.
      c. Certified field quality control test reports for required anchor performance tests.
   2. Qualifications Statements:
      a. Installer.
      b. Testing laboratory.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded, in ample time to prevent delay of that Work.
   2. Deliver accepted materials in original, unopened, undamaged, protective packaging, with manufacturer's and testing and inspection agencies labels accurately indicating brand name, pattern, size, thickness and fire-resistance-rating of packaged materials.
   3. All markings and labels shall be legible and intact.
   4. Inspect acoustical panel ceiling materials and reject components differing from accepted Samples and Shop Drawings. Immediately remove rejected components from the Site and do not incorporate into the Work.
   5. Handle materials in a manner that avoids chipping edges or damaging units in any way and as recommended by manufacturer's approved installation recommendations and the recommendations of specified standards.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store materials in a fully enclosed space where they will be protected against damage and constantly within limits of manufacturer's written recommended environmental conditions.
   3. Store materials in original protective packaging to prevent soiling, physical damage or wetting.
   4. Store cartons open at each end to stabilize moisture content and temperature.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.6 JOB CONDITIONS

A. Environmental Requirements:
   1. Before installing acoustical panels permit them to reach room temperature and
   2. Do not install interior acoustical panel ceilings until the space has been enclosed and is weathertight, and until installation of moisture-bearing material in the space has been

completed and the space is nominally dry, and until ambient conditions of temperature and humidity are continuously maintained at levels indicated for final occupancy.

B. Scheduling:
1. Do not begin installation of acoustical panel ceilings until all Work above ceilings has been completed and accepted by Engineer.
2. Furnish cast-in-place, and built-in-place anchors and their locations, to other trades for installation well in advance of time needed for coordinating locations of acoustical panel ceiling supports with other Work that must share plenum area above acoustical panel ceilings.

1.7 EXTRA MATERIALS

A. Extra Materials:
1. At time of completing the installation, deliver stock of extra material and store in a secure area at the Site as directed by Owner. Furnish full-size units, packaged with protective covering for storage, and identified with appropriate labels.
2. Acoustical Panels: Furnish an amount equal to two percent of the amount installed, or at least one full package of acoustical panels.
3. Do not provide partial packages of materials. Round-up quantities to furnish only complete, unopened and undamaged packages; with legible labels accurately representing contents of package indicating compliance with approved Samples and Shop Drawings, and matching materials actually installed.
4. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used on this Project, with calculations establishing quantity of extra materials to be furnished to Owner.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
1. General:
a. Standards: Provide manufacturer's standard acoustical panel ceiling systems that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light deflections.
b. References: In general, the recommendations of CISCA, "Acoustical Ceilings: Use and Practice" shall be considered part of this Section, unless otherwise specified.
c. Standards for Terminology and Performance: Applicable publications by the Ceiling and Interior Systems Construction Association (CISCA), including "Ceiling Systems Handbook" and ASTM C 635.
d. Provide complying UL acoustical panel ceiling systems to match acoustical panels in adjacent non-fire-resistance-rated acoustical panel ceiling assemblies. Where exact match is not available, submit samples of available complying acoustical panels for Engineer's selection.
2. Noise Reduction Coefficient (NRC): The average of sound absorption coefficients when tested in accordance with ASTM C 423 for a specification range of ten points, for middle frequencies of 250, 500, 1000, and 2000 Hertz with face of test specimen mounted in compliance with ASTM C 795 for Mounting Type E-400 (400 millimeter air space) standard mounting according to ASTM E 1264. Provide not less than the following:
a. NRC Rating: Range of 0.50, except as otherwise specified.

3. Ceiling Attenuation Class: Provide acoustical panel ceilings that have been tested for sound transmission loss through the acoustical tile ceiling, determined in accordance with ASTM E 1414 and ASTM E 413. Provide not less than the following:
    a. CAC Class: 40, for Mounting Type E-400.

2.2 CEILING PANELS

A. Performance Criteria:
1. General:
    a. Standards: Provide manufacturer's standard acoustical panel ceiling systems that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light deflections.
    b. References: In general, the recommendations of CISCA, "Acoustical Ceilings: Use and Practice" shall be considered part of this Section, unless otherwise specified.
    c. Standards for Terminology and Performance: Applicable publications by the Ceiling and Interior Systems Construction Association (CISCA), including "Ceiling Systems Handbook" and ASTM C 635.
2. Noise Reduction Coefficient (NRC): The average of sound absorption coefficients when tested in accordance with ASTM C 423 for a specification range of ten points, for middle frequencies of 250, 500, 1000, and 2000 Hertz with face of test specimen mounted in compliance with ASTM C 795 for Mounting Type E-400 (400 millimeter air space) standard mounting according to ASTM E 1264. Provide not less than the following:
    a. NRC Rating: Range of 0.50, except as otherwise specified.
3. Ceiling Attenuation Class: Provide acoustical panel ceilings that have been tested for sound transmission loss through the acoustical tile ceiling, determined in accordance with ASTM E 1414 and ASTM E 413. Provide not less than the following:
    a. CAC Class: 40, for Mounting Type E-400.

2.3 CEILING PANELS

A. General: Unless otherwise specified, provide standard lay-in panels of the type selected by Engineer. Provide sizes shown on reflected ceiling plans or, if not otherwise shown, 24-inch by 48-inch grid-size panels.

B. Acoustical Panels:
1. Mineral Fiber Acoustical Panels: Provide units not less than 15/163/4-inch thick and of density not less than 1.25 pounds per square foot, medium-coarse non-directional texture, NRC 0.50 to 0.60, STC 35-39, light reflectance over 67 percent. [1]
2. Surface Finish: Factory-applied white vinyl latex paint.
3. Product and Manufacturer: Provide one of the following:
    a. Cirrus Tegulant beveled edge by Armstrong World Industries, Inc.
    b. Frost shadow line tapered edge by USG.
    c. Or equal.

2.4 CEILING SUSPENSION SYSTEMS

A. General: Comply with ASTM C 635, as applicable to the type of suspension system required for the type of acoustical panel ceiling units specified.
1. Structural Class, Heavy-Duty System (Direct Hung): 16 pounds per linear foot of main runners, minimum.
    a. Main Runners: 0.020-inch thick metal, minimum.

b. Cross Tees: 0.020-inch thick metal, minimum.

B. Exposed Suspension System: Manufacturer's standard, 5/16-inch wide by 1-1/2-inch high exposed runners, cross-runners and accessories, with exposed cross runners stepped to lay flush with main runners; manufactured from hot-dipped galvanized G90, commercial steel CS Type B, complying with ASTM A 653; double-webbed construction with stainless steel clip end tap feature interlocking with cross tee slots to prevent lateral pull-out.
1. Finish of Exposed Members: Provide uniform factory-applied finish on exposed surfaces of ceiling suspension system including moldings, trim and accessories.
a. Finish: Manufacturer's standard baked enamel finish, white, unless otherwise selected by Engineer.

C. Products and Manufacturers: Provide one of the following:
1. 1200 System and Fire Front 1250 Direct Hung Suspension Systems by Chicago Metallic Corporation.
2. Or equal.

2.5 MISCELLANEOUS MATERIALS

A. Hangers:
1. Wire Hangers: Galvanized, soft-temper steel wire complying with ASTM A 641/A 641M, Class C zinc coating, pre-stretched; bare steel diameter of 8-gauge (0.162-inch).
2. Rod Hangers: Commercial steel complying with ASTM A 510, mild carbon steel; 1/4-inch bare steel rod diameter; hot-dip galvanized in compliance with ASTM A 153/A 153M, Class B-1.

B. Anchors:
1. Provide built in place anchors fabricated from stainless steel components complying with ASTM F 593 and ASTM F 594, Group 1, alloy Type 316 for bolts, and anchors with holes or loops for attaching hangers.
2. Comply with ASTM E 488 for concrete inserts, clips, bolts, screws and other devices applicable to the indicated method of structural anchorage for acoustical panel ceiling hangers.

C. Hold-Down Clips for Non-Fire-Resistance-Rated Ceilings: For interior ceilings consisting of acoustical panels weighing less than one pound per square foot, provide hold-down clips spaced 2 foot-0 inches on centers on all cross tees.

D. Sheet Metal Edge Molding and Trim: Type and profile shown, or if not shown, manufacturer's standard metal channel molding for edges and penetrations that fit acoustical panel edge details and suspension systems specified; formed from commercial grade sheet steel of same material, color and finish as used for exposed flanges of suspension system members.
1. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
2. For circular penetrations in ceiling, provide shop-fabricated edge moldings fabricated to diameter required to fit penetrations exactly.
3. For narrow-face suspension systems, provide suspension system and manufacturer’s standard edge moldings that match width and configuration of exposed runners.

E. Extruded Aluminum Edge Molding and Trim: Type and profile shown, or if not shown, manufacturer's standard extruded aluminum molding for edges and penetrations that fit acoustical panel edge details and suspension systems specified; including splice plates, corner pieces, and attachment and other clips, complying with the following:
   1. Aluminum Alloy: 6063-T5 complying with ASTM B 221.
   2. Finish of Exposed Members: Provide the following finish for all edge moldings and trim components:
      a. Finish: Manufacturer's standard baked enamel finish, white, unless otherwise selected by Engineer.

F. Acoustical Sealant for Exposed and Concealed Joints: Provide a modified acrylic-latex, non-sag, paintable, non-staining, sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints in building construction as demonstrated by testing representative assemblies according to ASTM E 90 and acceptable for use with UL Design Designations specified.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the conditions under which the acoustical panel ceiling Work is to be performed and notify Engineer, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

A. Concrete Inserts: Provide inserts for incorporation into formwork. Furnish layouts for cast-in-place ceiling support anchors whose installation is specified in other Sections.

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid the use of less-than-half width panels at borders, and comply with accepted Shop Drawing layout.

3.3 INSTALLATION

A. General:
   1. As a minimum standard, unless otherwise shown, specified, required by accepted Shop Drawings, or governing authorities having jurisdiction at the Site, install acoustical panel ceilings to comply with CISCA's "Ceiling System Handbook."
   2. Where acoustical panel ceilings must resist lateral forces, comply with requirements of governing authorities having jurisdiction at the Site and ASTM E 580.

B. Install suspension systems to comply with ASTM C 636, with hangers supported only from building structural members. Locate hangers near each end and spaced four feet along each carrying channel or direct-hung runners, unless otherwise shown.
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system.
   2. Splay hangers only where required and, if permitted by governing authorities having jurisdiction at the Site for fire-resistance-rated construction assemblies, to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.

3. Where width of ducts and other obstructions within ceiling plenum produces hanger spacing that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by Reference Standards and publications.
4. Secure wire hangers to ceiling suspension members by looping or wire-tying with a minimum of three tight turns, either directly to structure or to inserts, eye screws, clips or other anchorage devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Connect rod hangers directly to structural members, including additional framing members introduced for ceiling support, by attaching to inserts, eye-screws, or other devices and fasteners that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause hangers to deteriorate or otherwise fail due to age, corrosion or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
9. Do not connect or suspend steel framing from ducts, pipes or conduit.
10. Sway-brace suspended steel framing with hangers used for support.
11. Space hangers not more than 4 foot-0 inches on centers along each member, supported directly from hangers and provide hangers not more than 8-inches from ends of each member.
12. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from structural members as required for hangers, without attaching top permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
13. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

C. Arrange acoustical panels and orient directionally-patterned panels in the manner shown on accepted Shop Drawings.
1. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members.
2. Install acoustical panels with pattern running in one direction.
3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings.
5. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
6. Install hold-down clips in areas shown, and in areas where required by governing authorities having jurisdiction at the Site, or for fire-resistance-ratings; space as recommended by panel manufacturer, unless otherwise specified.

D. Install edge moldings and trim of the type shown at edges of each acoustical ceiling area, and at locations where edge of units would otherwise be exposed after completion of the Work.
1. Sealant Bed: Apply acoustical sealant in a continuous ribbon, concealed on back of vertical legs of molding before fastening to vertical surface.

2. Secure moldings to building construction by fastening with screw-anchors into the substrate, through holes drilled in vertical leg. Space holes not more than 3- inches from each end and not more than 16-inches on centers along each molding, leveling with ceiling suspension system to tolerances specified.
3. Miter corners of moldings accurately to provide hair-line joints, securely connected to prevent dislocation.
4. Do not use exposed fasteners, including blind rivets, on molding or trim.

E. Install sound attenuation insulation in areas shown. Lay insulation directly on ceiling system, and close major openings to completely cover all areas shown to receive sound attenuation insulation.

3.4 FIELD QUALITY CONTROL

A. Testing Agency:
1. Contractor shall engage a qualified independent testing agency, accepted by Engineer, to perform quality control testing.
2. Perform all specified testing in compliance with the requirements of ASTM E 488.
3. Extent and Testing Frequency: Testing shall take place in successive stages in areas described below. Proceed with installation of acoustical panel ceilings only after results for previously installed hangers comply with requirements.
4. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion, but no acoustical panels have been installed, perform the following tests:
   a. Within each test area testing agency will, select one of every ten anchors used to attach hangers to concrete and will test them for 1,140 pounds of tension. It will also select one of every two post-installed anchors used to attach bracing wires to concrete and will test them for 1,620 pounds of tension.
   b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until twenty consecutively pass and then will resume initial testing frequency.
5. Testing agency shall report test results promptly and in writing to Engineer.
6. Where fasteners and anchors are removed and replaced, additional testing shall be performed to determine compliance with specified requirements.

B. Allowable Tolerances:
1. Surfaces to Receive Acoustical Treatment: Free from irregularities and level to within 1/4-inch in 12 feet.
2. Deflection:
   a. Suspension System Components, Hangers, and Fastening Devices Supporting Light Fixtures, Ceiling Grilles, and Acoustical Units: Maximum deflection 1/360 of the span.
   b. Deflection Test: ASTM C 635.
3. Allowable Tolerance of Finished Acoustical Ceiling System: Level within 1/8-inch in 12 feet-0 inches.
4. Accessibility Percentage: 100.

3.5 ADJUSTMENT AND CLEANING

A. Do not proceed with installation of acoustical panels until testing is completed and non-complying fasteners and anchors have been replaced with new material complying with the requirements of these Specifications.

B. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings and suspension system members. Comply with manufacturer's written instructions for cleaning and touch-up of minor finish damage. Remove and replace Work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

C. Installer shall advise Contractor and Engineer of required protection for the acoustical panel ceilings, including manufacturer's recommended temperature and humidity limitations and dust control, so that the Work will be without damage and deterioration at the time of acceptance by Owner. Contractor shall provide required protection.

END OF SECTION 09 5113

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SECTION 09 6153

CONCRETE HARDENER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all concrete hardener Work.
   2. The extent of the concrete hardener includes all interior concrete floors not shown or scheduled to be finished with another material.
   3. The types of concrete hardener Work required include, but are not necessarily limited to, silicate penetrant.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the concrete hardener Work.
   2. Notify other contractors in advance of the installation of the concrete hardener Work to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the concrete hardener Work.

C. Related Sections:
   1. Section 03 3000, Cast-In-Place Concrete.

1.2 QUALITY ASSURANCE

A. Installer's Qualifications: Engage a single installer regularly engaged in the installation of concrete hardeners with five years experience in the application of the types of materials required, and who agrees to employ only tradesmen with specific skills and experience in this type of Work. Installer shall meet the requirements of the concrete hardener manufacturer for providing guarantee coverage. Submit name and qualifications to Engineer.

B. Source Quality Control: Obtain all material from only one manufacturer who will send a qualified technical representative to the Site for the purpose of advising the installer of proper procedures and precautions for the use of the material, at no additional cost to the Owner.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Copies of manufacturer’s specifications, recommendations and installation instructions. Include manufacturer’s published data, indicating the material complies with the requirements and is intended for the application shown.
      b. Submit installer's qualifications in accordance with Article 1.2, above.

B. Informational Submittals: Submit the following:
   1. Certificates: Submit a certificate of coverage signed by a duly authorized representative of the manufacturer.

C. Closeout Submittals: Submit the following:
   1. Maintenance Data: Upon completion of the Work, furnish five copies of detailed maintenance manual including the following information:
      a. Product name and number.
      b. Name, address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedure for light repair such as scratches and staining.
   2. Guarantee Documentation:
      a. Submit for approval written guarantee agreeing to replace the concrete hardener should it fail to perform as specified in Article 1.6, below.

1.4 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded, in ample time to prevent delay of that Work.
   2. Deliver materials in concrete hardener manufacturer's original unopened containers.
   3. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number and date of manufacturer.
      c. Mixing instructions, shelf life and curing time when applicable.
   4. Failure to comply with these requirements shall be sufficient cause for the rejection of the material in question, by Engineer, and requiring its removal from the Site. In such a case, supply new material conforming to the specified requirements, at no additional cost to Owner.
   5. Handle materials carefully to prevent inclusion of foreign materials.
   6. Do not open containers or mix components until all necessary preparatory Work has been completed.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store materials so as to preclude the inclusion of foreign material.
   3. Protect material from freezing.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.5 JOB CONDITIONS

A. Environmental Conditions:
   1. Do not apply concrete hardener to uncured concrete. Comply with manufacturer's written instructions for minimum ten days of curing time.
   2. Apply hardener only when temperature of concrete is 50°F or above.

B. Protection:

1. Do not allow concrete hardener to overflow or spill onto adjoining surfaces.
2. Remove concrete hardener that is splashed on surfaces not designated to receive concrete hardener immediately by flushing with water.

C. Sequencing:
1. Coordinate the Work so that the concrete hardener is installed when best results will be obtained, as recommended by the manufacturer's technical representative.

1.6 GUARANTEE

A. Provide a five year written guarantee, signed by Contractor and installer, stating that should concrete floors show signs of dusting because of wear and abrasion they will be re-installed, in the manner specified herein, at no additional cost to Owner, from the date of Final Acceptance of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Hardener: Provide a clear, colorless, aqueous solution of chemically active silicates and fluosilicates plus a wetting and penetrating agent, that reacts with the free lime and calcium carbonates to bind soft, loose particles together and form a hard dense vitreous surface which is resistant to chemical attack and the growth of mildew, fungi and other organisms. Use potable water only.

2.2 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:
1. Lapidolith by Sonneborn Division of Contech, Incorporated.
2. Armortop by Anti-Hydro Waterproofing Company.
3. Or equal.

2.3 MIXES

A. Follow manufacturer's written instructions for the proper mixing, dilution and coverage of each coat.

2.4 FINISH

A. The finished installation of the concrete hardener shall have a smooth, uniform even finish without discontinuities or discolorations.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the substrates and the conditions under which the concrete hardener Work is to be performed and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the concrete hardener. Do not proceed with the concrete hardener Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 SUBSTRATE PREPARATION

A. Steel trowel concrete in strict accordance with printed directions supplied by the concrete hardener manufacturer.

B. Provide concrete free of all honeycombing and fins.

C. Do not use sealers, curing or parting compounds on the concrete.

D. Provide wet curing only.

E. Surfaces to receive concrete hardener shall be clean, dry and free of all loose dirt, oil, wax and other foreign matter.

3.3 INSTALLATION

A. Provide the services of a manufacturer's technical representative for the purpose of advising the installer of proper procedures and precautions for the use of the material prior and during the installation of the concrete hardener.

B. Apply concrete hardener using the coverage recommended by the manufacturer per coat.

C. Apply a minimum of three separate coats.

D. Apply a fourth coat using undiluted material should the manufacturer's technical representative recommend this procedure, based on field conditions, and as directed by Engineer.

E. Apply each coat by spray.

F. Mop up excess solution or puddles.

G. After each of the first and second applications, allow the floor to dry until no longer visibly wet.

H. To avoid the development of crystals, when applying the third coat, flush the surface liberally with clean, hot water. At the same time, brush the floor rapidly with a stiff-bristle broom. Mop up excess water.

I. Follow manufacturer's written instructions should white crystals develop after the first or second coat. Consult manufacturer's technical representative.

3.4 ADJUSTMENT AND CLEANING

A. Clean adjacent surfaces of concrete hardener resulting from the Work. Use solvent or cleaning agent recommended by the concrete hardener manufacturer. Leave all finished Work in a clean neat appearance.

B. Protect the concrete hardener until fully cured.

END OF SECTION 09 6153

SECTION 09 6505

RESILIENT FLOORING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install resilient flooring.
   2. Extent of resilient flooring is shown.
   3. Types of products required include the following:
      a. Vinyl floor tile.
      b. Vinyl cove base and pre-molded cove base corners.
      c. Vinyl sanitary cove base and pre-molded sanitary cove base corners.
      d. Edging strips.
      e. Floor and tile adhesive.
      f. Cove adhesive.
      g. Miscellaneous accessories, fillers and fasteners.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with or before, the resilient flooring Work.
   2. Coordinate requirements for maximum safe moisture-emission level of concrete slabs in compliance with resilient flooring manufacturer's written recommendations and in compliance with ASTM E 1643 and Section 03 3000, Cast-In-Place Concrete.
   3. Coordinate the finishing of substrates for acceptability of substrates to resilient flooring manufacturer, as indicated on approved Shop Drawings.
   4. Remove all chemicals, compounds and other materials from substrates to receive the Work of this Section, as may be required by the resilient flooring manufacturer, even if other Sections permit chemicals, compounds and other materials.
   5. Coordinate and schedule filling and grinding of cementitious underlayments to avoid later difficulty or delay in performing the resilient flooring installation Work.
   6. Coordinate required thickness of cementitious underlayments with doors, thresholds, piping and equipment, adjacent materials and similar items in order to provide smoothly aligned transitions acceptable to Engineer and in compliance with governing authorities.
   7. Coordinate the use of products specified in other Sections to provide substrates acceptable to the resilient flooring manufacturer and Engineer.
   8. Coordinate the installation of moisture barriers and insulation, specified in other Sections, to substrates before the installation of resilient flooring.

C. Related Sections:
   1. Section 03 3000, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG.
2. ASTM C 501, Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
3. ASTM D 2047, Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
4. ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
5. ASTM E 648, Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
6. ASTM E 662, Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
7. ASTM E 1643, Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
8. ASTM F 386, Test Method for Thickness of Resilient Flooring Material Shaving Flat Surfaces.
9. ASTM F 540, Test Method for Squareness of Resilient Tile Flooring by Dial Gage Method.
10. ASTM F 710, Practice for Preparing Concrete Floors to Receive Resilient Flooring.
11. ASTM F 925, Test Method for Resistance to Chemicals of Resilient Flooring.
12. ASTM F 1344, Specification for Rubber Floor Tile.
13. F 1516- Practice for Sealing Seams of Resilient Flooring Products by the Heat Weld Method (when Recommended).
14. F 1700 Specification for Solid Vinyl Floor Tile.
15. F 1859 Specification for Rubber Sheet Floor Covering Without Backing.
16. F 1861, Specification for Resilient Wall Base.
17. F 1869, Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
18. ASTM F 1913, Specification for Vinyl Sheet Floor Covering Without Backing.
19. ASTM F 2170, Test Method for Determining Relative Humidity in Concrete Slabs in Situ Probes.
20. Code of Federal Regulations, CFR 59, Subpart D (EPA Method 24), National Volatile Organic Compound Emission Standards for Consumer Products.
21. ISO, 9002, Quality Systems - Model for Quality Assurance in Production, Installation and Servicing.
22. National Fire Protection Association, NFPA 253, Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
23. National Fire Protection Association, NFPA 258, Method of Test for Specific Density of Smoke Generated by Solid Materials.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Provide all components of resilient flooring system and auxiliary products produced by a single manufacturer, including recommended primers, adhesives and edging strips, as required.
   2. Provide products from manufacturer who participates in ISO certification programs and who manufacture resilient flooring systems and auxiliary products conforming to the requirements of those programs.

B. Installer's Qualifications:

1. Engage a single installer regularly performing installation of resilient flooring with documented skill and successful experience in the installation of the types of materials required; and who agrees to employee only tradesmen who are trained, skilled and have successful experience in installing the types of materials specified.
2. Submit name and qualifications to Engineer along with the following information on a minimum of three successful projects:
    a. Names and telephone numbers of owners, architects or engineers responsible for projects.
    b. Approximate contract cost of the resilient flooring.
    c. Amount of area installed.

C. Source Quality Control:
1. Furnish all components of resilient flooring system from a single manufacturer, and from a single supplier with adequate resources to provide products of consistent performance characteristics, physical properties and appearance, without delaying the Work.
2. Obtain materials only from manufacturers who will, if required, send a qualified technical representative to the Site, for the purpose of advising installer of proper procedures and precautions for the use of the materials.
3. Provide products from manufacturers who participate in ISO 9002 Quality Control Programs.
4. Colors and Patterns: Provide resilient floor tile and stair-covering units with uniformly distributed color and pattern throughout the thickness of the tile, except as otherwise specified. Variation in shades and off pattern matches between containers will not be acceptable.

D. Definitions:
1. Critical Radiant Flux (CRF): According to ASTM E 648, the measure of the ability of a floor covering to resist the spread of flames when located in a corridor exposed to flames and hot gases from a room fire. The higher the CRF value, the more resistant the material is to flame spread.
2. Excessive Wear: Loss of thickness of more than 0.0025-inches of rubber material per year based on specified traffic conditions.
3. Low Vibration Profile: The combination of resilient rubber compounds and tile profile design that will eliminate or noticeably reduce vibration of wheeled vehicles. Wheels of 4-inch diameter or greater should cause no vibration or noticeable sound and should not contribute to ambient noise.
4. Migrating Waxes: Waxes and soil-releasing agents that are chemically a component of the product's formulation, continually traveling to the product's surface when activated by use.
5. Non-Solvent Adhesives: Adhesives with a non-solvent base requiring no open time to permit solvent flash.
6. Optical Smoke Density: The optical density of smoke developed by burning a solid material, such as resilient flooring, established according to ASTM E 662.

E. Regulatory Requirements:
1. Wherever a flame spread, smoke development or CRF classification is shown or specified for resilient flooring (Class B, Class I and similar designations), provide components complying with applicable requirements for materials and installation established by ASTM, and other governing authorities having jurisdiction at the Site.

F. Mock-Ups:

1. Before proceeding with final purchase of materials and installation of resilient flooring systems, but after Engineer'S approval of Samples and Shop Drawings, install 100 square foot samples of each component of resilient flooring system, and one landing and run of stairs including all stair flooring components and accessory trim, indicating the final relationship and configurations of the various parts and components and the quality of workmanship that will be achieved in the Work. Locate mock-ups in areas selected by Engineer to show a representative installation of each type of resilient flooring system.
2. Incorporate materials and methods of installation that are identical to Project requirements.
3. Obtain Engineer'S acceptance of visual qualities of mock-up before start of resilient flooring system Work. Retain and protect mock-up during construction as a standard for judging completed resilient flooring. Do not alter or remove approved mock-ups.
4. Build as many mock-ups as required to obtain Engineer'S acceptance. Disassemble rejected mock-ups and remove all components from Site. Do not incorporate rejected mock-up components into the Work. Accepted mock-up may be incorporated into the finished Work.
5. Resilient flooring system Work that proceeds without approved mock-ups shall be stopped, and mock-ups prepared for Engineer'S approval.
6. Resilient flooring that does not meet the standard of workmanship on approved mock-ups shall be removed and replaced with new material.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Plans drawn to a scale of 1/4-inch equal to 1 foot-0 inch showing all flooring and all stair covering units and components accurately located in final positions as they will occur in the finished Work, and showing actual dimensions of areas to receive the Work. Show all patterns required for the Work and the location of each color and texture required for each tile pattern.
      b. Details drawn to a scale of 1-1/2-inches equal to 1 foot-0 inch showing all intersections of stair covering components with actual dimensions of stair treads, risers, landings and stringers and with all products accurately located and positioned as they will occur in the finished Work.
   2. Product Data:
      a. Copies of manufacturer's specifications and installation instructions for each type of resilient flooring, stair floor covering, auxiliary material and accessory required.
   3. Samples: Submit the following:
      a. Each type and color of resilient flooring and stair floor covering required. Provide full size samples of each type of flooring and stair covering product and 12-inch lengths of each auxiliary product and accessory specified.
      b. Samples shall show the full range of color and pattern variation. Sample submittals will be reviewed for color, texture and pattern only. Compliance with all other requirements is the responsibility of Contractor.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Product certificates signed by the manufacturer certifying materials comply with the specified performance characteristics and criteria, and physical requirements.
      b. Certified Installer.
   2. Test Results: Certified test reports showing compliance with specifiedperformance characteristics and physical properties.

3. Site Quality Control submittals:
    a. Existing Conditions Report.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data: Furnish five copies of manufacturer's instructions for recommended maintenance practices for each type of resilient flooring, including the following:
    a. Product name and number.
    b. Name, address and telephone number of manufacturer and local distributor.
    c. Detailed procedures for routine maintenance and cleaning.
    d. Detailed procedures for light repairs such as dents, scratches and staining

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with applicable requirements of referenced standards, Section 01 6500, Product Delivery Requirements and Section 01 6600, Product Storage and Handling Requirements.

1.6 JOB CONDITIONS

A. Existing Conditions:
1. the existing conditions effecting the surface preparation and installation of resilient flooring and submit a report to the Engineer before installation. Existing facilities must meet all the requirements listed in 1.6.B. below. All deficiencies must be corrected before beginning installation.

B. Environmental Requirements:
1. Do not begin installation until permanent environmental control systems are operating as needed to maintain consistent temperatures in installation areas. Continuously maintain temperature in areas to receive resilient flooring systems at 68°F for at least 48 hours prior to, during, and 48 hours after installation.
2. Perform moisture testing of cast-in-place concrete slabs when temperature in the spaces where resilient flooring will be installed is greater than 50°F.

C. Scheduling.
1. Schedule the arrival of materials to minimize storage on-Site and only as required by manufacturer to allow materials to acclimate to areas of installation.
2. Store only sufficient quantities of material on-Site as required to advance the Work without causing delays.
3. Close spaces to traffic during flooring installation and for time after installation recommended, in writing, by the resilient flooring manufacturer.
4. Install resilient flooring after other finishing operations, including painting, have been completed.
5. Where demountable partitions and similar demountable items are indicated for installation on top of resilient flooring, install resilient flooring before these items are installed.

1.7 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents.

B. Special Warranties:
   1. Resilient Flooring Wear Warranty: Provide written warranty, signed by Contractor and manufacturer and running to benefit of Owner, agreeing to replace, for a period of ten years from the date of Substantial Completion, resilient tile units that show excessive wear, as specified.

1.8 EXTRA MATERIALS

A. Extra Materials:
   1. Furnish extra materials from the same manufactured lot as the materials installed.
   2. Unless otherwise directed by the Engineer, furnish two percent of each type and color of resilient flooring, stair floor covering, auxiliary material and accessory used in the Work and store in a secure area at the Site as directed by Owner.
   3. Do not provide partial containers or packages of materials. Round-up quantities to furnish only complete, unopened and undamaged containers and packages; with legible labels accurately representing contents of container or package indicating compliance with approved Samples and Shop Drawings, and matching materials actually installed.
   4. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used on this Project, with calculations establishing quantity of extra materials to be furnished to Owner.
   5. Do not furnish materials whose remaining shelf life will be less than six months, at the time of Substantial Completion. Furnish only materials that are accompanied by a documented record of proof of being continuously stored and handled according to manufacturer's recommended storage and temperature limitations.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Description:
   1. Resilient tile flooring systems shall include a system of vinyl flooring tile, sanitary cove base moldings and factory-pre-molded outside and inside sanitary cove base molding corners and all components for stair floor covering, including angles, stringers, risers, treads and nosings and all auxiliary and accessory products, adhesives and fillers.
   2. The system shall also include all necessary vapor retarders and underlayments, specified and installed under other Sections, and all surface preparation, and testing to provide a complete system, and acceptable performance, complying with the requirements of these Specifications.

B. Performance Criteria:
   1. Optical Smoke Density, ASTM E 662: Less than 450.
   2. Critical Radiant Flux (CRF), ASTM E 648: Not less than 0.45 watts per square centimeter; Class 1.

2.2 MATERIALS

A. General: Manufactured units shall contain no polyvinylchloride or other halogens, and shall be completely asbestos-free.

B. Vinyl Tile Flooring:

1. homogeneous solid vinyl tile and sheet flooring, composed of binder, filler and pigments compounded with suitable lubricants and processing aids. The binder consists of one or more polymers or copolymers of vinyl chloride, other modifying resins, plasticizers and stabilizers. Polymers or copolymers of vinyl chloride comprise at least 60 percent of the weight of the binder. Any copolymer of vinyl chloride used shall contain at least 85 percentvinyl chloride.
2. Standards:
    a. Tile: ASTM F 1700, Class I.
    b. Sheet: ASTM F 1913.
3. Physical Properties: Provide the following:
    a. Abrasion Resistance, ASTM C 501 (H-18 Wheel, 500-gram load, 1,000 cycles): 0.40-gram loss weight, maximum.
    b. Hardness, ASTM D 2240 (Shore A): 85, minimum.
    c. Slip Resistance: ASTM D 2047, equal to or no greater than .5.
    d. Chemical Resistance, ASTM F 925:

Reagent	Resistance - 24 Hours
Acetic Acid - 5 percent	No Change
Ammonia - 28 percent	No Change
Sodium Hydroxide - 5 percent	No Change
Sulfuric Acid – 5 percent	No Change
Concentrated Cleaners	No Change

4. Size and Thickness: 12-inches by 12-inches by 0.125-inches thick, minimum.
5. Colors:
    a. Complete selection of manufacturer's standard colors for final selection by Engineer.
    b. Engineer will select a maximum of 6 colors.
6. Products and Manufacturers: Provide one of the following:
    a. Vinyl Tile by Armstrong World Industries, Incorporated.
    b. Vinyl Tile Flooring by Johnsonite Incorporated a Tarkett Company Incorporated.
    c. Or Equal

C. Vinyl Cove Base: Vinyl, composed of binder, filler and pigments compounded with suitable lubricants and processing aids.; 0.125-inches thick with connection dimension matching final resilient tile thickness; approximate 4 foot-0 inch long sections, with matching end stops and pre-molded inside and outside corner units, as follows:
1. Standard: ASTM F 1861, Style B, Group TV
2. Physical Properties: Refer to 2.2.F.3.above.
3. Accessories:
4. Size: 4-inches high.
5. Colors:
    a. Complete selection of manufacturer's standard and custom colors for final selection by Engineer.
    b. Engineer will select a maximum of 4 colors.
6. Products and Manufacturers: Provide one of the following:
    a. Tandem Vinyl Cove Base and Sanitary Base by Armstrong World Industries, Incorporated.
    b. Vinyl Cove Base and Sanitary Base by Johnsonite Incorporated a Tarkett Company Incorporated.
    c. Equal

D. Vinyl Accessories:

1. Feature Strips: Complete selection of vinyl strips, including transitional reducers, thresholds, tile joiners and caps. Size and color as shown, of the same material composition and thickness as the adjacent tile units.
2. Edging Strips: 1/8-inch thick, homogenous, vinyl, tapered or bullnosed edge, color as selected by Engineer from manufacturer's standard colors.
3. Rods: Homogenous, vinyl, color as selected by Engineer from manufacturer's standard colors.
4. Physical Properties: Refer to 2.2.F.3.above.

E. Metal Edge Strips: Width shown, of required thickness to protect exposed edge of resilient flooring. Provide units of maximum available length, to minimize number of joints.
1. Material: Extruded aluminum with mill finish, unless otherwise shown.
2. Type: Butt-type metal edge strips for concealed anchorage.

F. Auxiliary Products:
1. Concrete Slab Primer: Non-staining type recommended by the resilient flooring manufacturer.
2. Cementitious Underlayment: As recommended by the resilient flooring manufacturer.
3. Sanitary Base Cove, Non-Solvent Adhesive: Provide a fortified acrylic emulsion recommended by the resilient flooring manufacturer, maximum VOC's of 50 g/l.
4. Flooring and Stair Floor Covering, Non-Solvent Adhesive: Provide a high performance, solvent-free, two-part polyurethane adhesive with excellent resistance to moisture, heat and humidity, maximum VOC's of 50 g/l.
5. Epoxy Nose-Filler and Adhesive: Provide solvent-free, non-sag epoxy as recommended by resilient flooring manufacturer to completely fill all stair nosings to prevent cracking or flexing of treads and nosings by uniformly molding a bonding support for the step, maximum VOC's of 50 g/l.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the areas and conditions under which resilient flooring Work will be performed and notify Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

A. Confirm that moisture barriers, recommended by the resilient flooring manufacturer, installed under other sections, are properly installed.

B. Do not install products until they are at the same temperature as the space where they are to be installed.

C. Ensure that surfaces to receive resilient flooring are sufficiently cured, dry and are ready to receive resilient flooring installation as recommended by manufacturer, in writing.

D. Prepare cast-in-place concrete slabs in compliance with ASTM F 710. Remove substances incompatible with resilient flooring and adhesives using methods recommended, in writing, by the resilient flooring manufacturer.

E. Test cast-in-place concrete for moisture, in compliance with ASTM D 4263 and in compliance with RFCI. Perform testing, as developed by the Rubber Manufacturers Association calcium chloride test, in order to determine that the maximum safe moisture-emission level recommended by the resilient flooring manufacturer's written installation limitations will not be exceeded, before installation of resilient flooring.
   1. Allow thirty days drying time for each 1-inch of cast-in-place concrete slab thickness before testing concrete.
   2. Perform minimum of one test for every 1,000 square feet of floor area to receive resilient flooring.
   3. If moisture tests indicate unacceptable levels of moisture remaining in the slab, do not install resilient flooring. Report existing conditions, along with recommendations, to Engineer, in writing. Allow additional time for slab to dry and retest.
   4. Contractor may, at their option and expense, dehumidify or provide additional heat, in order to speed the drying process. If, after remediation measures are implemented, retesting the cast-in-place concrete continues to indicate unacceptable levels of moisture, submit resilient flooring manufacturer's recommended penetrating-sealer and remedial moisture barrier product for Engineer'S approval.

F. Perform relative humidity testing, using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum of 75 percent relative humidity measurement.

G. Perform one adhesive bond test for every 2,000 square feet of area receiving resilient flooring, but not less than one in each space, to verify acceptable adhesion of resilient flooring manufacturer's approved adhesive. Examine after 72 hours to determine whether bond is solid and no moisture is present. Do not proceed with Work until bond tests produce acceptable results.

H. Concrete pH Test: Perform pH test for every 2,000 square feet of area receiving resilient flooring, but not less than one in each space, to verify acceptable adhesion of linoleum flooring manufacturer's approved adhesive. If pH is greater than 10, concrete slab must be neutralized prior to beginning the installation.

I. Installation Surfaces:
   1. Survey surfaces to receive resilient flooring and verify tolerances are within limits specified. Do not install resilient flooring where surfaces are outside of allowable tolerances specified.
   2. Use leveling compound as recommended by resilient tile manufacturer for filling small cracks and depressions in installation surfaces.
   3. Level cast-in-place concrete surfaces, to receive resilient flooring, to provide concrete level to within 1/8-inch variation in ten-feet. Comply with recommendations of both the cementitious underlayment manufacturer's and resilient flooring manufacturer's written and approved recommendations for product compatibility and installation.
   4. Concrete floors with slick finish or with curing or hardening compounds shall be mechanically abraded using methods approved by the resilient flooring manufacturer.
   5. Prior to start of installation of resilient tile units, clean all surfaces to be covered with resilient flooring using high-efficiency particulate air filter vacuum cleaners and inspect the subfloor in accordance with manufacturer's instructions.

J. Concrete Primer: Apply concrete slab primer if recommended by resilient flooring manufacturer, prior to application of the adhesive. Apply in compliance with manufacturer's written and approved instructions.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Upon Owner's request and with at least 72 hours notice, provide manufacturer's field representative with product use recommendations and periodic site visits for inspection of flooring installation, in accordance with manufacture's instructions.
   1. Site Visits: One before, during and after installation.

B. Allowable Tolerances:
   1. Surfaces to Receive Resilient Flooring Systems: Surface shall be smooth, level, at the required finish elevation, without more than 1/8-inch in ten feet variation from level, or slopes, shown. Provide surfaces free of depressions, raised areas, or other defects that may telegraph through installed flooring.

3.4 INSTALLATION

A. Place resilient flooring units using manufacturer's dry laying installation method with all embossed arrows pointing in the same direction and with adhesive cement mixed in strict compliance with the manufacturer's written and approved installation instructions. Follow all product use precautions as recommended by the manufacturer.

B. Butt resilient flooring units tightly to vertical surfaces, thresholds, nosings and edgings. Scribe around obstructions to produce neat joints, laid tight, even and in straight, parallel lines. Extend resilient flooring units into toe spaces, door reveals, and into closet and similar openings.

C. Maintain reference markers, holes, or openings that are in place or plainly marked for future cutting by repeating on the finish resilient flooring as marked on the subfloor. Use chalk or other non-permanent marking devices.

D. Install resilient flooring on covers for telephone, electrical ducts and floor hatches, and other such items as occur within the finished resilient flooring areas. Maintain the overall continuity of color, joints, and pattern with resilient flooring installed on these covers. Tightly cement edges of resilient flooring to perimeter of sanitary cove base.

E. Lay resilient flooring from center marks established with principal walls, discounting minor offsets, so that resilient flooring at opposite edges of the room are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay resilient flooring square to room axis, unless otherwise shown.

F. Match resilient floorings for color and pattern by using resilient flooring from cartons in the same sequence as manufactured and packaged. Cut resilient flooring neatly around all obstructions. Broken, cracked, chipped or deformed resilient flooring shall be replaced.

G. Apply resilient flooring to flooring surfaces using a full spread of adhesive applied to flooring surface to comply with resilient flooring manufacturer's written approved instructions, including those for notching, adhesive mixing, and adhesive open and working times.

H. Tightly cement resilient flooring to flooring surfaces without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks through resilient tile, or other surface imperfections.

I. Lay resilient flooring with grain in all resilient tiles running in the same direction.

J. Place resilient edge strips tightly butted to resilient flooring and secure with adhesive. Provide edging strips at all unprotected edges of resilient flooring, unless otherwise shown.

K. Cove Base: Apply to all columns, pilasters, casework and other permanent fixtures in rooms or areas where base is required. Install base in as long lengths as practicable, with preformed corner units. Tightly bond base to backing throughout the length of each piece, with continuous contact at horizontal and vertical surfaces.
   1. On masonry surfaces, or other similar irregular surfaces, fill voids along top edge of resilient wall-base with manufacturer's recommended adhesive filler material.
   2. Install pre-molded outside and inside corners before installing straight pieces.

L. Metal Edge Strips:
   1. Apply butt-type metal edge strips where shown and prior to installing resilient flooring. Secure units to substrate with countersunk stainless steel screws, complying with manufacturer's recommendations for the type of substrate.

M. Resilient Accessories:
   1. Apply resilient accessories so they are butted to adjacent materials and bond to surfaces with adhesive. Install reducer strips at edges of flooring that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing resilient products:
   1. Remove all adhesive and other surface blemishes from resilient flooring, using neutral-type cleaners as recommended by the resilient flooring manufacturer.
   2. Vacuum floor thoroughly.
   3. Do not wash floor until after time period recommended by resilient flooring manufacturer.
   4. Damp-mop floor to remove marks and soil.

B. Protect installed flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of the construction period and to Substantial Completion. Use protection methods recommended in writing by the resilient flooring manufacturer.

C. Do not move heavy or sharp objects directly over floor surfaces. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

D. Clean floor surfaces not more than four days before scheduled inspection to determine Substantial Completion of the Work. Clean products according to manufacturer’s approved written recommendations.

E. Resilient flooring system components, damaged for any reason, shall be replaced with new, undamaged material, in compliance with the requirements of these Specifications, at no additional cost to the Owner.

END OF SECTION 09 6505

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SECTION 09 9100

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
      a. Contractor is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included in the general contract and other contracts described in this Section.
   2. Extent of painting includes the Work specified below. Painting shown in schedules may not provide Contractor with complete indication of all painting Work. Refer to Article 2.2 of this Section where all surfaces of generic types specified are specified for preparation and painting according to their status, intended function, and location, using the painting system for that surface, function, and location as specified, unless specifically identified on the Drawings as a surface not to receive specified painting system.
      a. Follow the Painting Schedule in Article 3.8.
      b. All new and specifically identified existing surfaces and items except where natural finish of material is specified as a corrosion-resistant material not requiring paint; or is specifically shown as indicated by written note, or specified as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.
      c. Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by Owner, are included in the Work, except as otherwise shown or specified.
      d. Removal of all substances, top coats, primers and all intermediate coats of paint and other protective or decorative coatings on those items and surfaces to remain that are identified to receive a painting system under this Section, to provide surfaces acceptable for application of painting specified.

B. Coordination:
   1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.
   2. Coordinate painting of areas that will become inaccessible once equipment and similar fixed items have been installed.
   3. Furnish information to Engineer on characteristics of finish materials proposed for use and ensure compatibility with prime coats used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify Engineer in writing of anticipated problems using specified painting systems with surfaces primed by others. Reprime equipment primed in factory and other factory-primed items that are damaged or scratched.

C. Related Sections:
   1. Section 07 9200, Joint Sealants.

D. Work Not Included: The following Work is not included as painting Work, or are included under other Sections or in other contracts:

1. Shop Priming: Shop priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-painted process equipment, plumbing equipment, heating and ventilating equipment, electrical equipment, and accessories shall conform to applicable requirements of this Section but are included under other Sections.
2. Pre-finished Items:
    a. Items furnished with such finishes as baked-on enamel, porcelain, and polyvinylidene fluoride shall only be touched up at Site by Contractor using manufacturer's recommended compatible field-applied touchup paint.
    b. Items furnished with finishes such as chrome plating or anodizing.
3. Concealed Surfaces: Non-metallic wall or ceiling surfaces in areas not exposed to view, and generally inaccessible areas, such as furred spaces, pipe chases, duct shafts, and elevator shafts.
4. Concrete surfaces.
5. Concrete floors, unless specifically shown as a surface to be painted.
6. Face brick, glazed structural tile, and prefaced, ground-faced or split-faced concrete unit masonry.
7. Exterior face of architectural precast concrete.
8. Collector bearings, shafts and chains, wood flights, wood stop logs, and wood or fiberglass baffles.
9. Corrosion-Resistant Metal Surfaces: Where the natural oxide of item forms a barrier to corrosion, whether factory- or Site-formed, including such materials as copper, bronze, muntz metal, terne metal, and stainless steel.
10. Operating Parts and Labels:
    a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors, and fan shafts.
    b. Do not paint over labels required by governing authorities having jurisdiction at Site, or equipment identification, performance rating, nameplates, and nomenclature plates.
    c. Cover moving parts and labels during the painting with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings, and splatter that comes in contact with such labels.
11. Structural and miscellaneous metals covered with concrete need not receive primers, intermediate, or finish coats of paint.
12. Existing structures, equipment, and other existing surfaces and items unless otherwise shown or specified.

E. Description of Colors and Finishes:
1. Color Selection:
    a. Engineer reserves the right to select non-standard colors for paint systems specified within ability of paint manufacturer to produce such non-standard colors. Provide such colors at no additional expense to Owner.
2. Color Coding of Pipelines, Valves, Equipment, and Ducts:
    a. Color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1, CFR 1910.144, Recommended Standards for Water Works, and Recommended Standards for Wastewater Facilities. For piping and equipment not covered by the above standards, conform to Owner’s color standards.
    b. For equipment located on roofs and equipment that is exposed-to-view, color will be selected by Engineer.

1.2 REFERENCES

A. Referenced Standards: Standards referenced in this Section are:
   1. ANSI A13.1, Scheme for Identification of Piping Systems.
   2. ANSI Z535.1, Safety Color Code.
   3. ASTM D16, Terminology for Paint, Related Coatings, Materials and Applications.
   4. ASTM D2200, Pictoral Surface Preparation Standards for Painting Steel Surfaces.
   5. ASTM D4262, Testing Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   6. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   7. ASTM D4541, Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
   8. ASTM E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
   9. Great Lakes Upper Mississippi River Board of Public Health and Environmental Managers (GLUMRB) Recommended Standards for Water Works.
   10. GLUMRB, Recommended Standards for Wastewater Facilities.
   11. Ozone Transport Commission, (OTC), OTC Model Rule for Architectural and Industrial Maintenance Coatings.
   12. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
   13. SSPC VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
   14. SSPC VIS 2, Method of Evaluating Degree of Rusting/Painted Steel Surfaces.
   15. SSPC Volume 2, Systems and Specifications.

1.3 DEFINITIONS

A. Coating terms defined in ASTM D16 apply to this Section.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Engage a single applicator regularly performing installation of painting systems, with documented skill and successful experience in installing types of products required and agrees to employ only tradesmen trained, skilled, and with successful experience in installing types of products specified.

B. Testing Agency Qualifications: Provide independent testing agency with experience and capability to satisfactorily conduct testing specified in accordance with ASTM E329. Testing agency shall be selected by Owner and paid for by Contractor.

C. Source Quality Control:
   1. Obtain products from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work to advise on products, mock-ups, installation, and finishing techniques, at completion of the Work to advise Engineer on acceptability of completed Work, and during course of Work as requested by Engineer.
   2. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and recoatability after curing.

3. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in painting systems.
4. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services indicated. Comply with the following:
    a. Lead and Chromate: Lead and chromate content shall not exceed amount allowed by authorities having jurisdiction.
    b. Through Contractor, paint manufacturer shall notify Engineer of colors that are not suitable for long-term color retention in areas subject to hydrogen sulfide fume exposure.
    c. Manufacturer shall identify colors that meet requirements of authorities having jurisdiction at Site for use in locations subject to contact with potable water or water that will be treated to become potable.
    d. Comply with paint manufacturers' recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint coatings.

D. Regulatory Requirements:
1. Comply with VOC content limits of Ozone Transport Commission (OTC), Model Rule for Architectural and Industrial Maintenance Coatings.

E. Pre-Painting Conference:
1. Conduct a pre-painting conference at the Site to review specified requirements. Meeting attendees shall include painting applicator and its foreman, paint manufacturer's technical representative, installers of other work in and around painting that must follow painting Work, Engineer, and other representatives directly concerned with performance of painting Work.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
1. Product Data:
    a. Copies of manufacturer's technical data sheets, including surface preparation, number of coats, dry film thickness, test performance data including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contact Documents, and application instructions for each product proposed for use
    b. Submit proof of acceptability of proposed application techniques by paint manufacturer selected.
    c. Copies of Contractor's proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.
    d. List each material and cross-reference to the specific painting system and application, including a list of site-specific surfaces to which painting system will be applied. Identify by manufacturer's catalog number and general classification. State number of gallons of each product being purchased for delivery to Site and square foot area calculated to be covered by each painting system specified based on theoretical loss of 20 percent. Where actual area to be covered by paint system exceeds area submitted to Engineer for that system, proof of additional material purchase shall be provided to Engineer. Calculated coverage shall be as specified

for each component of each painting system specified. This requirement does not take precedence over Contractor's responsibility to provide dry film thickness required for each component of each painting system.

e. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.

f. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.

g. Specification for spray equipment with cross-reference to paint manufacturer's recommended equipment requirements.

2. Samples:

a. Copies of manufacturer's complete color charts for each coating system.

B. Informational Submittals: Submit the following:

1. Certificates:

a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.

b. Contractor shall provide notarized statement verifying that all painting systems are compatible with surfaces specified. All painting systems components shall be reviewed by an authorized technical representative of paint manufacturer for use as a compatible system. Verify that all painting systems are acceptable for exposures specified and that paint manufacturer is in agreement that selected systems are proper, compatible, and are not in conflict with paint manufacturer's recommended specifications. Show by copy of transmittal form that a copy of letter has been transmitted to paint applicator.

2. Test Reports:

a. Certified laboratory test reports for required performance and analysis testing in compliance with ASTM E329.

b. Adhesion testing plan and procedures.

c. Results of adhesion testing on existing surfaces containing paints or other coatings to be topcoated with paint systems specified. Prior to adhesion testing, submit a testing plan establishing methods, procedures and number of tests in each area where existing coatings are to remain and become substrate for painting Work. Based on results of adhesion testing, recommend methods, procedures, and painting system modifications, if necessary, for proceeding with Work.

d. Locations of and test methods for soil sampling before beginning Work and after Substantial Completion.

e. Proposed methods for testing, handling, and disposal of waste generated during Work.

f. Results of alkalinity and moisture content tests performed per ASTM D4262 and ASTM D4263.

g. Results of film thickness, holidays, and imperfections tests.

3. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.

4. Manufacturer's Site Reports: Provide report of paint manufacturer's representative for each visit to Site by paint manufacturer's representative.

5. Special Procedure Submittals:

a. Proposed protection procedures for each area of Work, explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a

manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption.
b. Site-specific health and safety plan.
c. Procedures for maintaining acceptable application, curing and environmental conditions during and after painting systems application.
d. Procedures for providing adequate lighting, ventilation, and personal protection equipment relative to painting Work.

6. Qualifications:
a. Applicator.
b. Testing laboratory

C. Closeout Submittals: Submit the following:
1. Maintenance Manual: Upon completion of the painting Work, furnish Engineer five copies of detailed maintenance manual including the following information:
a. Complete and updated product catalog of paint manufacturer's currently available products including complete technical information on each product. Identify product names and numbers of each product used in the painting Work.
b. Name, address, e-mail address and telephone number of manufacturer, local distributor, applicator and technical representative.
c. Detailed procedures for routine maintenance and cleaning.
d. Detailed procedures for light repairs such as dents, scratches and staining.
2. Statement of Application: Upon completion of the painting Work, submit a notarized statement to Engineer signed by Contractor and painting applicator stating that Work complies with requirements of the Contract Documents and that application methods, equipment, and environmental conditions were proper and adequate for conditions of installation and use.

1.6 DELIVERY, STORAGE AND HANDLING

A. Product Delivery Requirements: Deliver products to Site in original, new, and unopened packages and containers, accurately and legibly and accurately labeled with the following:
1. Container contents, including name and generic description of product.
2. Manufacturer's stock number and date of manufacture.
3. Manufacturer's name.
4. Contents by volume, for major pigment and vehicle constituents.
5. Grams per liter of volatile organic compounds.
6. Thinning instructions, where recommended.
7. Application instructions.
8. Color name and number.

B. Product Storage Requirements:
1. Store acceptable materials at Site.
2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
3. Store products that are not in actual use in tightly covered containers.
4. Comply with health and fire regulations of authorities having jurisdiction at Site.

C. Product Handling Requirements:
1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.

2. Do not open containers or mix components until necessary preparatory work has been completed and approved by Engineer and painting Work will start immediately.
3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.7 SITE CONDITIONS

A. Site Facilities:
1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system applications, are not available at the Site.
2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance, and temperature-monitoring personnel is Contractor's responsibility.
3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent heat sources to exterior so that paint systems and personnel are unaffected by exhaust products.

B. Existing Conditions:
1. Existing surfaces to receive painting Work shall have their surfaces prepared to meet requirements of painting systems specified. Prior to initiating painting Work, perform adhesion tests on existing surfaces to be painted. Perform testing per ASTM D4541 or other method acceptable to Engineer. Number and location of tests shall be sufficient to determine the condition of existing coatings and suitability of existing coatings to remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide Engineer the adhesion test results.
2. Provide abrasive blasting, scraping, or other abrading or surface film removal, or preparatory techniques accepted by Engineer.
3. Before commencing painting in an area, surfaces to be painted and floors shall be cleaned of dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air (HEPA) filters and dust containment systems.
4. After painting operations have started in a given area, cleaning only with commercial vacuum cleaning equipment with high-efficiency particulate air (HEPA) filters and dust containment systems.

C. Environmental Requirements:
1. Comply with manufacturer's published requirements.

D. Protection:
1. Cover or otherwise protect finished Work of other trades and those surfaces not being painted concurrently and not to be painted.
2. During surface preparation and painting, facility shall remain in operation. Use procedures that prevent contamination of process or cause or require facility shutdown.
3. Coordinate and schedule surface preparation and painting to avoid exposing personnel to hazards associated with painting Work. Provide required personnel safety equipment per requirements of authorities having jurisdiction at Site.
4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work until Engineer accepts protection techniques proposed by Contractor.
5. When working with flammable materials, provide fire extinguishers and post temporary signs warning against smoking and open flame.

PART 2 - PRODUCTS

2.1 PAINTING SYSTEM MANUFACTURERS

A. Products and Manufacturers: Where referenced under painting systems, provide painting systems manufactured by the following:
   1. Tnemec Company, Incorporated (TCI).
   2. The Carboline Company, subsidiary of RPM International Inc (TCC).
   3. Sherwin-Williams Company (SWC).
   4. Or equal.

2.2 PAINTING SYSTEMS

A. New Ferrous Metals, Structural Steel, Miscellaneous Ferrous Metals, Exterior Surfaces of Valves, Exterior Surfaces of Ferrous Piping, and Exterior Surfaces of All Ferrous Metal; Non-submerged, Interior:
   1. Shop Primer:
      a. Generic Components:
         1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.
   2. Field Primer and Touch-Up:
      a. Generic Components:
         1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum
      b. Products and Manufacturers: Provide one of the following:
         1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); One coat, 4.0 to 6.0 dry mils.
   3. Finish: High-Gloss:
      a. Generic Components:
         1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy or polyamido-amine epoxy coating; 250 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC): One coat, 4.0 to 6.0 dry mils.

B. New and Existing Ferrous Metals, Galvanized Metals and Non-Ferrous Metals and Exterior Surfaces of Piping; Submerged and Intermittently Submerged, including up to 4.0 feet above liquid surface; Certified per ANSI/NSF Standard 61; Moderate VOC Content, Interior:
   1. Surface Preparation: Refer to Paragraphs 1.5.A.2, 3.2.A., 3.2.C.1., 3.2.C.2., 3.2.D. and 3.2.E.
   2. Primer/Finish:
      a. Generic Components:
         1) Minimum 100 percent solids, modified polyamine epoxy or flake-filled epoxy; 8 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series 22 Pota-Pox 100 (TCI); Plastite 140 S (TCC); Dura-Plate UHS NSF (SWC): Two coats, 8.0 to 10.0 dry mils, per coat.

C. New and Existing Ferrous Metals, Non-Ferrous Metals, and Galvanized Metals; Low VOC Content, Non-Submerged, Exterior:
   1. Surface Preparation: Refer to Paragraphs 1.5.A.2., 3.2.A., 3.2.C.1., 3.2.C.2., 3.2.D., 3.2.E., and 3.2.F.
   2. Ferrous Metal Primer:
      a. Generic Components:
         1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy coating; 250 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series V69 Hi-Build Epoxoline (TCI); Carboguard 890 LT (TCC); Macropoxy HS (SWC): One coat, 4.0 to 6.0 dry mils.
   3. Ferrous Metal Touch-Up:
      a. Generic Components:
         1) For Low-temperature Curing Conditions: Minimum 80 percent solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum.
         2) For Warm-temperature Curing Conditions: Minimum 80 percent volume solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) For Low-temperature Curing Conditions: Series 136, Chembuild FC (TCI); Carboguard 890 LT (TCC); Macropoxy HS Epoxy (SWC): One coat, 10.0 dry mils.
         2) For Warm-temperature Curing Conditions: Series 166 Epoxoline HS (TCI); Carboguard 1207 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 6.0 dry mils.
   4. Galvanized and Non-Ferrous Primer.
      a. Generic Components:
         1) Refer to Paragraph 2.2.R.2.a.1), above.
      b. Products and Manufacturers: Provide one of the following:
         1) Refer to Paragraph 2.2.R.2.b.1), above.
   5. Intermediate – Ferrous Metals Only:
      a. Generic Components:
         1) Refer to Paragraph 2.2.R.3.a.1), above.
         2) Refer to Paragraph 2.2.R.3.a.1), above.
      b. Products and Manufacturers: Provide one of the following:
         1) Refer to Paragraph 2.2.R.3.a.1), above.
         2) Refer to Paragraph 2.2.R.3.b.1), above.
   6. Finish: Gloss:
      a. Generic Components:
         1) Minimum 49 percent volume solids, two-component, waterborne acrylic polyurethane or aliphatic acrylic polyurethane coating; 247 grams per liter VOC, maximum.
      b. Products and Manufacturers: Provide one of the following:
         1) Series 1080 Endura-Shield WB (TCI); Carbothane 134 VOC (TCC); Centurion WB Urethane (SWC): Two coats, 2.0 to 3.0 dry mils.

D. New and Existing Galvanized Metal, Non-Ferrous Metal, and Fiberglass; Non-submerged, Interior:
   1. Surface Preparation: Refer to Paragraphs 1.5.A.2., 3.2.A., 3.2.D., 3.2.E. and 3.2.F.
   2. Primer:

a. Generic Components:
1) Minimum, 39 percent volume solids single-component, self-cross linking acrylic primer-sealer, 140 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 115 Uni-Bond DF (TCI); Galoseal Wash Primer (TCC); Pro-Cryl Universal Primer (SWC): One coat, 2.0 to 4.0 dry mils.

3. Finish: Satin:
a. Generic Components:
1) Minimum, 41 percent volume solids, single component, self-cross linking acrylic; 208 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 116 Uni-Bond (TCI); Carbocrylic 3359 (TCC); DTM Acrylic Coating (SWC): One coat, 2.0 to 4.0 dry mils.

E. New and Existing Aluminum in Contact with Dissimilar Materials:
1. Surface Preparation: Refer to Paragraphs 1.5.A.2., 3.2.A. and 3.2.D.
2. Primer/Finish:
a. Generic Components:
1) Minimum 100 percent volume solids, high-build, two-component, polyamido-amine or polyamine epoxy; 49 grams per gallon VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 165 Epoxoline 100 (TCI); Carboguard 954 HB (TCC); Dura-Plate UHS (SWC): Two coats, 8.0 to 15.0 dry mils, per coat.

F. New and Existing PVC and CPVC Piping and Fiberglass Insulation Covering; Non-submerged, Interior:
1. Surface Preparation: Refer to Paragraphs 1.5.A.2., 3.2.A. and 3.2.F.
2. Primer:
a. Generic Components:
1) Minimum 37 percent volume solids single-component, self-cross linking acrylic primer-sealer; 226 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 115 Uni-Bond DF (TCI); Carbocrylic 3358 (TCC); DTM Acrylic Primer/Finish (SWC): One coat, 2.0 to 4.0 dry mils.
3. Finish: Satin:
a. Generic Components:
1) Minimum 37 percent volume solids, single component, self-cross linking acrylic; 226 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 116 Uni-Bond (TCI); Carbocrylic 3358 (TCC); DTM Acrylic Primer/Finish (SWC): One coat, 2.0 to 4.0 dry mils.

G. New and Existing Exterior Surfaces of Steel Pipe; Buried Exterior:
1. Surface Preparation: Refer to Paragraphs 1.5.A.2., 3.2.A., 3.2.C.1., and 3.2.E.
2. Primer/Finish:
a. Generic Components:
1) Minimum 75 percent volume solids, build, coal tar polyamide epoxy coating; 330 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 46 Hi-Build H-413 Tneme-Tar (TCI); Bitumastic 300M (TCC); Targuard (SWC): Two coats, 9.0 dry mils, per coat.

H. New and Existing Concrete Unit Masonry Walls; Moderate Corrosion and Abrasion Resistant, Non-submerged, Interior:
1. Surface Preparation: Refer to Paragraphs 1.5.A.2., 3.2.A., 3.2.B.1., 3.2.B.2. and 3.2.B.8.
2. Filler, Surfacer and Patching Compound:
a. Generic Components:
1) Minimum 68 percent volume solids, high-build, three-component, waterborne cementitious acrylic block filler; 75 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 130 Envirofill (TCI); Sanitile 600 TG (TCC); Cement-Plex 875 (SWC): One coat, 10 to 14 dry mils.
3. Intermediate/Finish:
a. Generic Components:
1) Minimum 80 percent volume solids, high-build, chemical-resistant, high-gloss, modified, polyamine or polyamido-amine catalyzed epoxy finish; 180 grams per liter VOC, maximum.
b. Products and Manufacturers: Provide one of the following:
1) Series 280 Tneme-Glaze (TCI); Carboguard 890 LT (TCC); Cor-Cote HP (SWC):
a) Horizontal Surfaces: Two coats, 6.0 to 12.0 dry mils, per coat.
b) Vertical Surfaces: Two coats, 4.0 to 8.0 dry mils, per coat.

I. New and Existing Exterior Surfaces of Ductile Iron Process Pipe; Buried Exterior:
1. Refer to Section 40 0519, Ductile Iron Process Pipe.

2.3 CALKING AND SEALANTS

A. Refer to Section 07 9200, Joint Sealants.

2.4 INSTRUMENTS

A. Instruments:
1. Provide one new dry-film thickness gauge for checking film thickness, one holiday detector to detect holidays or holes in the coating, and one set of visual standards to check surface preparation. Calibrate dry film thickness gauge at Site using Bureau of Standards standard shim blocks Products and Manufacturers, provide the following:
a. Film Thickness Testers: Model FM-III manufactured by Mikrotest, or equal.
b. Holiday detector shall be Model M-1 as manufactured by Tinker & Rasor, or equal.
c. Visual Standards: ASTM D2200, Swedish Standards, SSPC VIS 1.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which painting Work is to be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for long-term adherence and durability of painting systems specified, or where

paint manufacturer requires removal of all existing paint to recommend use of specified painting system.

3.2 SURFACE PREPARATION

A. General:
   1. Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.

3.3 PROTECTION OF PROPERTY AND STRUCTURES

A. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation, and painting Work.

B. Use shrouding, vacuum blasting, or other acceptable methods for cleaning and surface preparation of exterior surfaces.

C. During blast cleaning and surface preparation of interior and exterior surfaces, control exhausting of dust and grit using shrouding, negative-pressure containment/dust collection systems, or other means to protect adjacent property and structures and prevent dust and grit from escaping. Similarly, control removal and temporarily store residues to protect adjacent property and structures.

D. For painting of exterior surfaces, use rollers, shrouding, or other acceptable methods as required to protect adjacent property and structures from wind-blown paint residues.

E. Submit proposed procedures for cleaning, surface preparation, and paint application that describe in detail methods to be used to protect adjacent property and structures from residues. Do not proceed with cleaning, surface preparation, or painting until proposed procedures are accepted by Engineer.

3.4 MATERIALS PREPARATION

A. General: Mix and prepare painting products in strict accordance with paint manufacturer's product data sheets.

3.5 APPLICATION

A. General:
   1. Apply paint systems by brush, roller, or airless spray per paint manufacturer's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Volume 2, where applicable, and in strict accordance with paint manufacturer's product data sheets.
   2. Surfaces of items not normally exposed-to-view do not require same color as other components of system of which they are a part, but require same painting system specified for exposed surfaces of system.
   3. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.
   4. Paint backs of access panels and removable or hinged covers to match exposed surfaces.
   5. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint to shop-primed coats and pre-finished items only when approved by Engineer using

compatible primers and paint manufacturer's recommended compatible field-applied finishes.

6. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.

B. Minimum/Maximum Paint Film Thickness: Comply with manufacturer's published recommendations for coating type and surface.

C. Scheduling Surface Preparation and Painting: Comply with manufacturer's published recommendations for coating type and surface.

D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to result in a finish coat with no burn-through or other defects caused by insufficient sealing.

E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

F. Brush Application:
1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
2. Brush-apply all primer or first coats, unless otherwise allowed to use mechanical applicators.

G. Mechanical Applicators:
1. Use mechanical methods for applying paint when allowed by applicable ordinances, paint manufacturer, and approved by Engineer.
2. Limit roller applications, if approved by Engineer, to interior wall finishes for second and third coats. Apply each roller coat to provide equivalent hiding as brush-applied coats.
3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of two coats in one pass.

H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by Engineer.

3.6 FIELD QUALITY CONTROL

A. Notify Engineer after completing each coat of paint. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by Engineer, proceed with succeeding coat. Provide testing instruments specified in Article 2.4 of this Section for testing by Contractor. Testing instruments shall become property of Owner.
1. Engineer will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.

B. For magnetic substrates, measure thickness of dry film nonmagnetic coatings following recommendations of SSPC PA-2. These procedures supplement manufacturers' approved instructions for manual operation of measurement gauges and do not replace such instructions.

C. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit testing results to Engineer.

3.7 ADJUSTMENT AND CLEAN-UP

A. Correct damage to work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to Engineer.

B. During progress of the Work, remove from Site all discarded paint products, rubbish, cans, and rags at end of each workday.

C. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

D. At completion of Work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by Engineer.

END OF SECTION 09 9100

SECTION 09 9600

HIGH PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including, but not limited to, Division 1, General Requirements.

1.2 DESCRIPTION OF WORK

A. The Contractor shall provide all labor, materials and equipment necessary to install coating systems for water and wastewater facilities. Section includes surface preparation, shop coating and field coating of exterior and interior items and surfaces. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint all exposed new substrates listed in Part 2, except as follows:
   1. Corrosion-resistant surfaces such as aluminum, brass, and stainless steel.
   2. Concrete, except interior building walls, interior surface of wet well(s), and chemical containment(s). All concrete floors to be coated in accordance with Division 09, Section "Interior Painting" and in accordance with the room finish schedule on the Architectural Drawings.
   3. Equipment supplied with a factory finish coating equivalent to the coating specified in Part 2.

1.3 REFERENCES

A. Abbreviations and Acronyms:
   1. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

B. Definitions: ASTM D 16, unless otherwise specified.

C. Reference Standards:

1.	ASTM D16	Standard Terminology for Paint, Related Coatings, Materials and Applications
2.	ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
3.	ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
4.	ICRI Guideline No. 03732	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
5.	NAPF 500-03	Surface Preparation Standard For Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
6.	SSPC-SP1	Solvent Cleaning
7.	SSPC-SP 2	Hand Tool Cleaning
8.	SSPC-SP 3	Power Tool Cleaning

9. SSPC-SP 5 White Metal Blast Cleaning
10. SSPC-SP 6 Commercial Blast Cleaning
11. SSPC-SP 10 Near-White Metal Blast Cleaning
12. SSPC-SP 11 Power Tool Cleaning to Bare Metal
13. SSPC-SP 12 Ultra-High-Pressure Water-Jetting
14. SSPC-SP 13 Surface Preparation of Concrete

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate and ensure compatibility of shop-applied primers with the specified field-applied coatings.

B. Scheduling: Provide the paint submittals within 30 days of the Notice to Proceed.

1.5 SUBMITTALS

A. Action Submittals/Informational Submittals:
   1. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, storage requirements and application instructions.
   2. Color Samples: Submit manufacturer’s color samples showing full range of standard colors.
   3. Submit manufacturer’s certification that coatings comply with specified requirements and are suitable for intended application.
   4. Applicator’s Quality Assurance: Submit list of a minimum of five completed projects of similar size and complexity to this Work. Include for each project:
      a. Project name and location.
      b. Name of owner.
      c. Name of contractor.
      d. Name of engineer.
      e. Name of coating manufacturer.
      f. Approximate area of coatings applied.
      g. Date of completion.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Specialize in manufacture of coatings with a minimum of 5 years of successful experience.
      b. Demonstrate successful performance on comparable projects.
      c. Single-Source Responsibility: Coatings and coating reducers shall be products of a single manufacturer.
   2. Applicator:
      a. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.
      b. Applicator's Personnel: Employ persons trained for application of specified coatings.

B. Job Mock-Up:

1. Minimum 10 sq. ft. application of each specified coating system on each type of substrate.
2. Mock-ups will serve as standard for acceptance of work.
3. Leave approved mock-ups in place as part of completed project.
4. Manufacturer's representative shall be available to advise applicator on proper application techniques and procedures.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging. Paint material containers which do not display manufacturer's product identification will not be acceptable. Container labels to clearly identify:
1. Coating or material name.
2. Manufacturer.
3. Color name and number.
4. Batch or lot number.
5. Date of manufacture.
6. Mixing and thinning instructions.

B. Storage:
1. Store materials in a clean dry area and within temperature range shown on the manufacturer's written instructions.
2. Keep containers sealed until ready for use.
3. Do not use materials beyond manufacturer’s shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination.

1.8 FIELD CONDITIONS

A. Weather:
1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer’s written instructions.
2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer’s instructions.
4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
5. Wind: Do not spray coatings if wind velocity is above manufacturer’s limit.

B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D102.

C. Dust and Contaminants:
1. Schedule coating work to avoid excessive dust and airborne contaminants.
2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.
3. Protect all surfaces not to be coated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carboline Company.

B. Sherwin Williams, Protective & Marine Coatings.

C. Tnemec Inc.

2.2 COATING SYSTEMS, GENERAL

A. The number of coats specified is the minimum required. If additional coats are required to achieve the specified dry film thickness or to provide complete coverage, provide additional coats at no additional cost to the Owner.

B. Material Compatibility: Provide block fillers, primers, and finish coat materials that are compatible with one another and with the substrates indicated under conditions of service and application as recommended by manufacturer, based on testing and field experience.

C. Material Quality: Provide manufacturer's best quality paint material of the various coating types specified that are factory-formulated and recommended by manufacturer for application indicated.

D. Colors: As selected by Engineer from manufacturer's full range, and as scheduled in Part 3.

2.3 COATING SYSTEMS FOR FERROUS METALS

A. Ferrous Metals, Interior, Non-Submerged (includes structural steel, miscellaneous steel and steel piping):
   1. Surface Preparation: SSPC-SP6 Commercial Blast
   2. Shop Primer:
      a. Carboline Carboguard 60 @ 3.0 - 5.0 DFT
      b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
      c. Sherwin Williams Macropoxy 646 or Copoxy Shop Primer @ 3.0 - 5.0 DFT
   3. Field Preparation: SSPC-SP11 Power Tool Cleaning or Surface Preparation: SSPC-SP6 Commercial Blast
   4. Field Touch-Up:
      a. Carboline Carboguard 60 @ 3.0 - 5.0 DFT
      b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
      c. Sherwin Williams Macropoxy 646 or Copoxy Shop Primer@ 3.0 - 5.0 DFT
   5. Finish:
      a. Carboline Carboguard 60 @ 4.0 - 6.0 DFT
      b. Tnemec 66-Color H.B. Epoxoline @ 4.0 – 6.0 DFT
      c. Sherwin Williams Macropoxy 646 @ 4.0 - 6.0 DFT
   6. Total DFT: 7.0 - 11.0 mils

B. Ferrous Metals, Interior or Exterior, Submerged or Intermittently Submerged in wastewater:
   1. Surface Preparation: SSPC-SP10 Near White Blast
   2. Shop Primer:
      a. Carboline Carboguard 635 @ 3.0 - 5.0 DFT

b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
c. Sherwin Williams Dura-Plate 235 @ 3.0 – 5.0 DFT

3. Field Preparation: SSPC-SP10 Near White Blast
4. Field Spot Prime:
   a. Carboline Carboguard 635 @ 3.0 - 5.0 DFT
   b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
   c. Sherwin Williams Dura-Plate 235 @ 3.0 – 5.0 DFT
5. Stripe Coat:
   a. Carboline Carboguard 635
   b. Tnemec 161-1255 Fascure
   c. Sherwin Williams Dura-Plate 235
6. Finish:
   a. Carboline Bitumastic 300 M @ 8.0 - 10.0 DFT
   b. Tnemec 46H-413 HB Tneme-Tar @ 8.0 - 10.0 DFT
   c. Sherwin Williams Hi-Mil Sher-Tar Epoxy @ 8.0 – 10.0 DFT
7. Total DFT: DFT 11.0 - 15 mils

C. Ferrous Metals, Encased in Concrete and Cementitious Substances:
1. Surface Preparation: SSPC-SP6 Commercial Blast
2. Primer/Finish:
   a. Carboline Carboguard 60 @ 4.0 - 6.0 DFT
   b. Tnemec 66 H.B. Epoxoline @4.0 - 6.0 DFT
   c. Sherwin Williams Macropoxy 646 @4.0 -6.0 DFT
3. Field Preparation: SSPC-SP11 Power Tool Cleaning
4. Touch-Up:
   a. Carboline Carboguard 60 @ 4.0 - 6.0 DFT
   b. Tnemec 66 H.B. Epoxoline @ 4.0 - 6.0 DFT
   c. Sherwin Williams Macropoxy 646 @4.0 -6.0 DFT
5. Total DFT: 4.0 - 6.0 mils

D. Ferrous Metals, Exterior, Non-Submerged:
1. Surface Preparation: SSPC-SP6 Commercial Blast
2. Shop Primer:
   a. Carboline Carbozinc 859 @ 2.5 - 3.5 DFT.
   b. Tnemec 90-97 Tneme-Zinc @ 2.5 - 3.5 mil
   c. Sherwin Williams Corothane I Galvapac @ 2.5 – 3.5 DFT
3. Field Preparation: SSPC-SP6 Commercial Blast or SSPC-SP11 Power Tool Cleaning
4. Field Touch-Up:
   a. Carboline Carbozinc 859 @ 2.5 – 3.5 DFT
   b. Tnemec 90-97 Tneme-Zinc @ 2.5 - 3.5 DFT
   c. Sherwin Williams Corothane I Galvapac @ 2.5 – 3.5 DFT
5. Field Intermediate:
   a. Carboline Carboguard 60 @ 2.0 - 3.0 DFT
   b. Tnemec 66 - Color Epoxoline @ 2.0 - 3.0 DFT
   c. Sherwin Williams Macropoxy 646 @ 2.0 – 3.0 DFT
6. Finish:
   a. Carboline Carbothane 133 HB @ 2.0 - 4.0 DFT
   b. Tnemec 1075 Endura-Shield @ 2.0 - 4.0 DFT
   c. Sherwin Williams Acrolon 218HS or Hi-Solids Polyurethane @ 2.0 – 4.0 DFT
7. Total DFT: 6.5 - 10.5 mils

E. Ferrous Metals, Buried, Exterior (structural & miscellaneous steel, piping):
1. Surface Preparation: SSPC-SP10 Near White Blast
2. Shop Primer:
   a. Carboline Bitumastic 300 M @ 8.0 - 10.0 DFT
   b. Tnemec 46H-413 Tneme-Tar @ 8.0 - 10.0 DFT
   c. Sherwin Williams Hi-Mil Sher-Tar Epoxy @ 8.0 – 10.0 DFT
3. Finish:
   a. Carboline Bitumastic 300 M @ 8.0 - 10.0 DFT
   b. Tnemec 46H-413 Tneme-Tar @ 8.0 - 10.0 DFT
   c. Sherwin Williams Hi-Mil Sher-Tar Epoxy @ 8.0 – 10.0 DFT
4. Total DFT: 16.0 - 20.0 mils

2.4 COATING SYSTEMS FOR DUCTILE AND CAST IRON PIPE

A. Ductile and Cast Iron Pipe - Interior Non-Submerged:
1. Surface Preparation: NAPF 500-03
2. Shop Primer:
   a. Carboline Carboguard 60 @ 3.0 - 5.0 DFT
   b. Tnemec 161 - 1211 Fascure @ 3.0 - 5.0 mils
   c. Sherwin Williams Macropoxy 646 @ 3.0 – 5.0 DFT
3. Field Preparation: NAPF 500-03-03 Power Tool Cleaning, NAPF 500-03-04 Abrasive Blast Cleaning for Ductile Iron Pipe or NAPF 500-03-05 Abrasive Blast Cleaning for Cast Ductile Iron Fittings
4. Field Touch-Up:
   a. Carboline Carboguard 60 @ 3.0 - 5.0 DFT
   b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
   c. Sherwin Williams Macropoxy 646 @ 3.0 – 5.0 DFT
5. Finish:
   a. Carboline Carboguard 60 @ 4.0 - 6.0 DFT
   b. Tnemec 66-Color HB Epoxoline @ 4.0 - 6.0 DFT
   c. Sherwin Williams Macropoxy 646 @ 4.0 – 6.0 DFT
6. Total DFT: 7.0 - 11.0 mils

B. Ductile and Cast iron Pipe - Exterior Non-Submerged:
1. Surface Preparation: NAPF 500-03
2. Shop Primer:
   a. Carboline Carboguard 60 @ 3.0 - 5.0 DFT
   b. Tnemec 161 - 1211 Fascure @ 3.0 - 5.0 DFT
   c. Sherwin Williams Macropoxy 646 @ 3.0 – 5.0 DFT
3. Field Preparation: NAPF 500-03-03 Power Tool Cleaning, NAPF 500-03-04 Abrasive Blast Cleaning for Ductile Iron Pipe or NAPF 500-03-05 Abrasive Blast Cleaning for Cast Ductile Iron Fittings
4. Field Touch-Up:
   a. Carboline Carboguard 60 @ 3.0 - 5.0 DFT
   b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
   c. Sherwin Williams Macropoxy 646 @ 3.0 – 5.0 DFT
5. Intermediate:
   a. Carboline Carboguard 60 @ 4.0 - 6.0 DFT
   b. Tnemec 66 - Color HB Epoxoline @ 4.0 - 6.0 DFT
   c. Sherwin Williams Macropoxy 646 @ 4.0 – 6.0 DFT
6. Finish:

a. Carboline Carbothane 133 HB @ 2.5 - 4.0 DFT
b. Tnemec 73 - Color Endurashield @ 2.5 - 4.0 DFT
c. Sherwin Williams Acrolon 218HS or Hi-Solids Polyurethane @ 2.5 – 4.0 DFT

7. Total DFT: 9.5 - 15.0 mils

C. Ductile and Cast iron Pipe – Submerged in Wastewater:
1. Surface Preparation: NAPF 500-03
2. Shop Primer:
a. Carboline Carboguard 635 @ 3.0 - 5.0 DFT
b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
c. Sherwin Williams Dura-Plate 235 @ 3.0 – 5.0 DFT
3. Field Preparation: NAPF 500-03-03 Power Tool Cleaning, NAPF 500-03-04 Abrasive Blast Cleaning for Ductile Iron Pipe or NAPF 500-03-05 Abrasive Blast Cleaning for Cast Ductile Iron Fittings
4. Field Touch-Up:
a. Carboline Carboguard 635 @ 3.0 - 5.0 DFT
b. Tnemec 161-1211 Fascure @ 3.0 - 5.0 DFT
c. Sherwin Williams Dura-Plate 235 @ 3.0 – 5.0 DFT
5. Finish:
a. Carboline Bitumastic 300 M @ 8.0 - 10.0 DFT
b. Tnemec 46H-413 HB Tneme-Tar @ 8.0 - 10.0 DFT
c. Sherwin Williams Hi-Mil Sher-Tar Epoxy @ 8.0 – 10.0 DFT
6. Total DFT: 11.0 - 15.0 mils

2.5 COATING SYSTEMS FOR NON-FERROUS METALS

A. Non-Ferrous Metals, Submerged or Intermittently Submerged in Liquids:
1. Surface Preparation: SSPC-SP10 Near White Blast
2. Shop Primer:
a. Carboline Carboguard 61 @ 3.0 - 5.0 DFT
b. Tnemec FC20-1255 Pota-Pox @ 3.0 - 5.0 DFT
c. Sherwin Williams Macropoxy 646PW @ 3.0 – 5.0 DFT
3. Field Preparation: Spot SSPC-SP10 Near White Blast
4. Field Spot Prime:
a. Carboline Carboguard 61 @ 3.0 - 5.0 DFT
b. Tnemec 20-1255 Pota-Pox @ 3.0 - 5.0 DFT
c. Sherwin Williams Macropoxy 646PW @ 3.0 – 5.0 DFT
5. Finish:
a. Carboline Carboguard 61 @ 4.0 - 6.0 DFT
b. Tnemec 20-AA90 Pota Pox @ 4.0 - 6.0 DFT
c. Sherwin Williams Macropoxy 646PW @ 4.0 – 6.0 DFT
6. Total DFT: 7.0 - 11.0 mils

B. Galvanized, Aluminum and other Non-Ferrous Metals - Interior:
1. Surface Preparation: Oakite 747LTS and rinse
2. SSPC-SP3 Power Tool Cleaning for rust areas
3. Primer:
a. Carboline Carboguard 880 @ 2.0 - 3.0 DFT
b. Tnemec 66 HB Epoxoline @ 2.0 - 3.0 DFT
c. Sherwin Williams Macropoxy 646 @ 2.0 – 3.0 DFT
4. Finish:

a. Carboline Carboguard 60 @ 2.0 - 3.0 DFT
b. Tnemec 66 HB Epoxoline @ 2.0 - 3.0 DFT
c. Sherwin Williams Macropoxy 646 @ 2.0 – 3.0 DFT

5. Total DFT: 4.0 - 6.0 mils

C. Galvanized, Aluminum and Non-Ferrous Metals - Exterior:
1. Surface Preparation: Oakite 747LTS and rinse
2. SSPC-SSPC-SP7 or NACE 4- Brush-Off Blast Cleaning for rusted areas
3. Primer:
a. Carboline Carboguard 60 @ 2.0 - 3.0 DFT
b. Tnemec 66-Color Epoxoline @ 2.0 - 3.0 DFT
c. Sherwin Williams Macropoxy 646 @ 2.0 – 3.0 DFT
4. Finish:
a. Carboline Carbothane 133 HB @ 2.0 - 4.0 DFT
b. Tnemec 73 Endura-Shield @ 2.0 - 4.0 DFT
c. Sherwin Williams Acrolon 218HS or Hi-Solids Polyurethane @ 2.0 – 4.0 DFT
5. Total DFT: 4.0 - 7.0 mils

2.6 COATING SYSTEMS FOR CONCRETE AND CONCRETE BLOCK

A. Concrete Surfaces for Chemical Containment(s):
1. Surface Preparation: ICRI, International Concrete Repair Institute Guideline No. 310.2 and SSPC-SP13.
2. Primer:
a. Carboline Semstone 110 @ 8.0- 10.0 DFT
b. Tnemec 201 Epoxoprime @ 8.0 - 10.0 DFT
c. Sherwin Williams General Polymers 3579 @ 8.0 – 10.0 DFT
3. Finish:
a. Carboline Semstone 140 @ 25.0- 30.0 DFT
b. Tnemec 281 Tneme-Glaze @ 25.0 - 30.0 DFT
c. Sherwin Williams General Polymers . 3744 @ 25.0 – 30.0 DFT
4. Total DFT: 33.0 - 40.0 mils

B. Concrete Surfaces Submerged or Intermittently Submerged in Wastewater:
1. Surface Preparation: ICRI, International Concrete Repair Institute Guideline No. 310.2 and SSPC-SP13.
2. Primer:
a. Tnemec 46H-413 Tneme-Tar @ 8.0 - 10.0 DFT
b. Carboline Bitumastic 300M @ 8.0- 10.0 DFT
c. Sherwin Williams Hi-Mil Sher-Tar Epoxy @ 8.0 – 10.0 DFT
3. Finish:
a. Tnemec 46H-413 Tneme-Tar @ 8.0 - 10.0 DFT
b. Carboline Bitumastic 300M @ 8.0- 10.0 DFT
c. Sherwin Williams Hi-Mil Sher-Tar Epoxy @ 8.0 – 10.0 DFT
4. Total DFT: 16.0 - 20.0 mils

C. Cover all concrete surfaces in the wet well interior, including full-length of walls, floors, ceilings, pre-cast troughs, and grout fill areas.

2.7 COATING SYSTEMS FOR PVC

A. PVC Piping:

1. Surface Preparation: Sand lightly; wipe clean with xylene.
2. Primer:
    a. Carboline Carboguard 893 SG @ 2.0 - 3.0 DFT
    b. Tnemec N69-Color HB Epoxoline @ 2.0-3.0 DFT
    c. Sherwin Williams Macropoxy 646 @ 2.0 – 3.0 DFT
3. Finish:
    a. Carboline Carboguard 893 SG @ 2.0 - 3.0 DFT
    b. Tnemec N69-Color HB Epoxoline @ 2.0-3.0 DFT
    c. Sherwin Williams Macropoxy 646 @ 2.0 – 3.0 DFT
4. Total DFT: 4.0-6.0 mils

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

3.2 PREPARATION

A. Protection of In-place Conditions: Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Surface Preparation: Prepare surfaces in accordance with this paragraph and the requirements listed in Part 2.
1. General
    a. Dislodge dirt, rust, plaster nibs, mortar spatter and other dry material by scraping or brushing. Remove dust and loose material by brushing, sweeping, vacuuming or blowing with compressed air.
    b. Remove oil, wax and grease by scraping off heavy deposits and cleaning with mineral spirits or a hot trisodium phosphate solution followed by a water rinse.
    c. Verify surfaces to be coated are dry, clean and free of dust, dirt, oil, wax, grease or other contaminants.
2. Non-Submerged Concrete, Masonry and Cement Stucco
    a. Allow new concrete and masonry to cure 28 days. Test for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.
    b. Scrape and grind fins and protrusions flush with surface.
    c. Patch holes and cracks flush with surface.
    d. Rake mortar joints clean.
3. Plaster
    a. Remove nibs and other protrusions by scraping flush with surface.
    b. Patch voids and cracks with spackling compound to match texture or surface.
4. Gypsum Board
    a. Sand joint compound smooth and flush with surface using fine-grit sandpaper.
    b. Fill nicks, scratches, holes and uneven spots with spackling compound and sand flush with surface after dry.
5. Non-Ferrous Metal: SSPC-SP1 to remove all contaminants or detergent wash/rinse with "Add H2O" Hyperconcentrate.
6. Submerged steel shop-primed with epoxy must be lightly abraded or whipblasted.

7. Galvanized Metal: Remove contaminants by SSPC-SP1 Solvent Cleaning. Detergent clean with Oakite 747LTS. Lightly abrade for immersion service.
8. Wood
    a. Remove surface deposits of sap and pitch by scraping and cleaning with mineral spirits.
    b. Seal knots and pitch pockets with a product manufactured for this specific purpose.
    c. Sand rough spots of smooth siding and finish woodwork.
    d. After prime coat is dry, fill cracks and holes with a suitable wood filler or spackling compound and sand flush with surface when dry.
9. Concrete Floors and Submerged Concrete: Prepare in accordance with ICRI, International Concrete Repair Institute Guideline No. 03732 and SSPC-SP13 Surface Preparation of Concrete using the appropriate degree of preparation for the intended surface.

3.3 APPLICATION

A. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels, unless specifically noted otherwise.

B. Apply coatings in accordance with manufacturer's instructions.
1. For porous masonry surfaces and concrete, apply first coat to completely fill voids and surface irregularities and to eliminate all pinholes.
2. Allow each coat to dry thoroughly before recoating. Follow manufacturer's recommended recoat time.

C. Mix and thin coatings, including multi-component materials, in accordance with manufacturer’s instructions.

D. Keep containers closed when not in use to avoid contamination.

E. Do not use mixed coatings beyond pot life limits.

F. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer’s instructions.

G. Uniformly apply coatings at spreading rate required to achieve specified DFT.

H. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

I. Stripe-paint with brush critical locations on steel such as welds, corners, and edges using specified primer.

J. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

K. Protect surfaces of coating systems from damage during construction.

3.4 REPAIR

A. Materials and Surfaces Not Scheduled to Be Coated: Repair or replace damaged materials and surfaces.

B. Damaged Coatings: Touch up or repair damaged coatings. Touch-up of minor damage will be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.5 CLEANING

A. Remove temporary coverings and protection of surrounding areas and surfaces.

B. Remove paint spatters from glass, plumbing fixtures, and adjoining surfaces.

C. Remove debris from job site and leave storage areas clean.

3.6 SCHEDULES

A. Pipe Color Coding Schedule:
   1. Contents and direction of flow shall be stenciled on the piping in a contrasting color.

Piping and Abbreviation	**PIPING**	**LETTERING**	**BACKGROUND**
POTABLE WATER			
Potable water, cold	Dark blue	Black	Light Green
Potable hot water, supply	Dark blue / white bands	Black	Yellow
Potable hot water, return	Dark blue / aluminum bands	Black	Yellow
PROCESS (FOR NON-STAINLESS STEEL PIPE)			
Blended Water (BLW)	Dark Blue	Blue	White
Cleaning Solution Concentrate Return (CSCR)	Stencil process flow only	Red	White
Cleaning Solution Feed (CSF, CSF1, CSF2)	Stencil process flow only	Red	White
Cleaning Solution Permeate Return (CSPR)	Stencil process flow only	Red	White
NF Bypass (NFB)	Aqua	Black	White
NF Concentrate (NFC)	Light Brown	Black	White
NF Feed (NFF)	Blue	Black	White
NF Permeate (NFP)	Blue	Black	White
NF Permeate Dump (NFD)	Red / Light Blue Bands	Black	White
Raw Water (RW)	Olive green	Black	White
Sample lines	Same as sampled process	Black	White
Sanitary Drain	Dark Gray / Black Bands	Black	White
Vent (Plumbing)	Match Wall Color	Black	Yellow
Vent (Process)	Yellow	Blue	White

Piping and Abbreviation	PIPING	LETTERING	BACKGROUND
CHEMICALS			
Antiscalant (A.S.)	Stencil process flow only	Black	White
Fluoride (FLOUR.)	Stencil process flow only	Black	White
Corrosion Inhibitor (PHOS.)	Stencil process flow only	Black	White
Sodium Hydroxide (NaOH)	Stencil process flow only	Black	White
Sodium Hypochlorite (NaOCl)	Stencil process flow only	Black	White
Sodium Bisulfite ($NaHSO_3$)	Stencil process flow only	Black	White
MISCELLANEOUS (FOR NON-STAINLESS STEEL PIPE)			
Instrument Air (AIR)	Dark Green	Black	White
Fire Protection Piping	Red	White	Red
Natural Gas	Orange	White	Black

END OF SECTION 09 9600

SECTION 09 9673

COATING SYSTEMS FOR CHEMICAL FEED AREAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications sections apply to this Section.

1.2 DESCRIPTION OF WORK

A. Section includes coating systems for secondary containment for chemical feed storage areas in wastewater facilities, including below-grade concrete chemical containment trenches above-grade containment sumps and walls.

B. The following areas within each chemical feed area shall be coated:
   1. Floors
   2. Sumps
   3. Walls (up to top of secondary containment area)

1.3 DELIVERY, STORAGE, AND HANDLING

A. Comply with the requirements specified in Division 01, Section “Product Requirements”.

B. Material shall be delivered to project site in manufacturer's original unopened containers.

C. Material shall be stored indoors, protected from damage, moisture, direct sunlight, and temperatures below 40 deg F or above 90 deg F.

1.4 ENVIRONMENTAL CONDITIONS

A. Surface and surrounding air temperatures must exceed 55 deg F but must be less than 90 deg F with materials at not less than 70 deg F during application. Do not apply if the relative humidity is more than 90% or the surface temperature is less than 5% above the dew point of the air in the working area.

1.5 QUALIFICATIONS OF APPLICATOR

A. Installation shall be performed by an applicator having satisfactory experience in the application of these or similar materials or with on-site consultation by a qualified field service representative from the manufacturer.

1.6 SUBMITTALS

A. Submittals shall follow requirements of Division 01, Section “Submittal Procedures”.

B. Prior to commencing work, submit to owner, manufacturer's technical information and installation details describing materials to be used.

C. Owner, contractor, and manufacturer shall review and mutually agree upon color, grade, and final texture of coating system before starting installation. The acceptance of a sample will constitute the job standard by which installation will proceed.

PART 2 - PRODUCTS

2.1 MATERIALS (OPTION #1)

A. Surfacer: Series 218 Mortar Clad epoxy modified cement.

B. Primer: Series 201 Epoxoprime, penetrating polyamine cured epoxy primer.

C. Reinforced Coating: Series 275 Novolac Stranlok fiber reinforced coating.

D. Glaze Coat: Series 282 Tneme-Glaze, pigmented epoxy novolac.

E. Manufacturer
1. Tnemec Company, Incorporated
3974-A Brown Park Dr.
Hilliard , Ohio 43026-1168
1-800-890-7580
2. Carboline Company.
3. Sherwin Williams; Industrial and Marine Coatings (S-W).
4. PolySpec (Thiokol).
5. Sprayroq

2.2 MATERIALS (OPTION #2)

A. Primer: Dudick Inc, Primer 67

B. Resurfacer: Scratch Coat 300

C. Reinforced Coating: Protecto-Flex 100XT, Fiberglass mat reinforced with 100 mil crack protection guarantee.

D. Manufacturer
1. Dudick
1818 Miller Pkwy
Streetsboro, Ohio 44241
1-800-322-1970

PART 3 - EXECUTION

3.1 PREPARATION

A. Allow new concrete to cure for 28 days. Verify dryness by testing for moisture by using calcium chloride discs and with the "plastic film tape-down test". (Reference ASTM D 4263)

B. Preparation (Materials Option #1)
1. Degrease and clean to remove all surface contaminants as needed. Mechanically abrade all concrete by means of self-contained, blasting equipment or equal, to remove all

laitance and surface contaminants and provide a minimum profile similar to 40-60 grit sandpaper. (Reference ASTM D 4259 and ICRI CSP 4-5)

C. Preparation (Materials Option #2)
   1. Concrete must be prepared mechanically to remove surface laitance. Oils, grease or other contaminant must be removed prior to surface preparation. Concrete must be free of curing compounds and form release agents. Surface texture should be similar to 40-60 grit sandpaper or the visual standard, CSP-5 from the International Concrete Repair Institute with exposed pea gravel. The prepared surface should have a minimum tensile strength of 250 PSI per ASTM D-4541.

D. After mechanically abrading, verify that all surfaces are clean, dry, and free of any contaminants, which could adversely affect the adhesion of the flooring system.

3.2 SPECIFICATION FOR WALLS, FLOORS, SUMPS AND TRENCH DRAINS

A. Installation (Materials Option #1)
   1. Surfacing: Fill all bugholes, spalled areas and surface imperfections with 218 MortarClad. Concrete block to be filled using Series 130 Envirofill.
   2. Cove: Floor and wall transitions are to have a 2-inch cant or radius cove. This will provide a seamless wall to floor transition.
   3. Priming: Series 201 Epoxoprime primer shall be mechanically mixed and applied in accordance with manufacturer's printed instructions and applied uniformly at a film thickness of 6.0 to 8.0 dry mils DFT. It should be topcoated after 2 hours and within 16 hours.
   4. Fiber Reinforced Coating: Install Series 275 Stranlok by spray application or trowel in a minimum of 2 passes to a total dry film thickness of 40.0 – 60.0 mils DFT.
   5. Glaze Coat: Series 282 epoxy novolac glaze coat shall be mechanically mixed in accordance with manufacturer's printed instructions and applied in a single application at a film thickness 8.0 - 12.0 mils DFT.
   6. Joints: Active expansion, construction and control joints are to be honored unless determined otherwise by the owner or project engineer. Joints and epoxy floor terminations are to be keyed and shall be sawed through the Coating system and filled with an appropriate Polysulphide flexible sealant.

B. Installation (Materials Option #2)
   1. Priming: Dudick Inc Primer 67 shall be mechanically mixed and applied in accordance with manufacturer's printed instructions and applied uniformly at a film thickness of 3.0 to 5.0 dry mils DFT.
   2. Resurfacing: Mechanical preparation removes laitance, exposing honeycombs or voids beneath the surface which must be filled with Dudick Inc Scratch-Coat 300.
   3. Fiber Reinforced Coating: Protecto-Flex 100XT shall be an epoxy lining consisting of 1/16” trowel applied basecoat, one layer of fiberglass mat reinforcement, and a flake filled epoxy topcoat at 20 mils DFT.
   4. Joints: Active expansion, construction and control joints are to be honored unless determined otherwise by the owner or project engineer. Joints and epoxy floor terminations are to be keyed and shall be sawed through the Coating system and filled with an appropriate Polysulphide flexible sealant. Such as Dudick Caulk 149

C. Job Standard: Prior to commencing the installation, the contractor shall install, with the owner's approval, a mutually agreed upon test sample to show final color and appearance of the system. This test area shall serve as a job standard for the final installation.

D. Cleanup: Remove waste materials, rubbish, and debris and dispose of them at the owner's direction. Leave work areas in a clean condition.

E. Protection
   1. Protect the completed work from water, airborne particles or other surface contaminants until cured for a minimum of 24 hours after application.
   2. Protect from traffic, physical abuse, immersion and chemical exposure until the complete system has thoroughly cured for the minimum equivalent of 24 hours at 75°F. For different temperatures, consult the manufacturer's representative about curing times.

3.3 CONTRACT CLOSEOUT

A. Provide in accordance with Section 01 7700.

END OF SECTION 09 9673

SECTION 09 9726

CEMENTITIOUS COATINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, appurtenances, specialty items and services as shown, specified and required to furnish and install the complete cementitious coatings Work.
   2. The extent of the cementitious coatings includes surface preparation and application of cementitious coating systems on the following substrates:
      a. Exterior concrete as shown.

B. Coordination:
   1. The manufacturer of the materials specified herein shall be required to review and satisfy all relevant requirements of other Sections and the requirements of the Drawings. Contractor, manufacturer, supplier, fabricator and/or subcontractors furnishing and/or installing materials, equipment, services and specialties associated with this Section shall fully coordinate their efforts.
   2. Review installation procedures under other Sections and coordinate the Work to produce substrate surfaces free from contaminants incompatible with the cementitious coatings Work, and substrates acceptable to the cementitious coatings installer for completely acceptable product performance.
   3. Contractor shall provide all labor, equipment, materials, appurtenances, specialty items and services not provided by Contractor’s manufacturers, suppliers, fabricators and/or subcontractors, but required to furnish and install the complete and operable systems.

C. Related Sections:
   1. Section 03 3000, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM):
      a. ASTM C 672 - Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
      b. ASTM D412 (modified) - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension..
      c. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials ("Wet Cup" Procedure)..
      d. Gemite ISO TP (Test Procedure) 005-97 - Tensile Properties of Thin Cement Composites.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Provide a single installer, approved by the approved cementitious coatings manufacturer who is regularly engaged in interior ceiling finish systems Work and has a minimum of five years experience in the installation of the types of materials specified.

B. Component Supply and Compatibility: Contractor shall obtain all materials from the same manufacturer and do the following:
   1. Provide the services of a qualified manufacturer's technical representative at the Site at the commencement of Work and during the time when the mock-up Work is being constructed to advise on materials, installation and finishing techniques.

C. Job Mock-Ups:
   1. Prior to the installation of the cementitious coatings Work, but after Engineer's approval of Shop Drawings, build free-standing 4 foot by 6 foot sample panels of each type of complete cementitious coatings on same substrate material that will be used in the Work, to show a representative installation of each complete cementitious coatings Work, including final texture and colors. Stage sample panel Work to leave exposed a 12-inch wide band of each component required in the Work. Obtain Engineer's acceptance of visual qualities of the mock-ups before start of cementitious coatings Work. Retain and protect mock-up during installation as a standard for judging completed cementitious coatings Work. Do not destroy mock-up until given permission by the Engineer.
   2. Cementitious coatings Work that does not meet the standard approved on the sample areas shall be removed and replaced by Contractor at Contractor's expense.
   3. Job Mock-ups that do not have an exposed portion of each system component shall be rejected.

D. Pre-Installation Meeting:
   1. Prior to the installation of the cementitious coatings Work Contractor shall schedule a Pre-Installation Meeting to review the following.
      a. Review project requirements, including all Contract Documents.
      b. Procedure for on-Site inspection and acceptance of cementitious coatings substrate and pertinent details (for example, mock-up installation).
      c. Contractor's plan for the coordination of Work of the various trades involved in providing cementitious coatings and other components.
   2. Pre-Installation Meeting shall be attended by Contractor, cementitious coatings manufacturer's technical representative, personnel directly responsible for installation of the cementitious coatings. Before beginning cementitious coatings Work, Contractor shall confirm, in writing, the resolution of conflicts among those attending the Pre-Installation Meeting.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Copies of manufacturer's specifications, recommendations and installation instructions. Include manufacturer's published data, indicating the material complies with the requirements and is intended for the application shown.
      b. Submit installer's qualifications in accordance with Article 1.4, above.

B. Informational Submittals: Submit the following:

1. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency, for each product formulation.

C. Closeout Submittals: Submit the following:
   1. Maintenance Data: Upon completion of the Work, furnish five copies of detailed maintenance manual including the following information:
      a. Product name and number.
      b. Name, address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedure for light repair such as scratches and staining.
   2. Guarantee Documentation:
      a. Submit for approval written guarantee agreeing to replace the concrete hardener should it fail to perform as specified in Article 1.6, below.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in cementitious coatings manufacturer's original unopened packages.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number, color and date of manufacture.
      c. Mixing instructions, shelf life and curing time, when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by Engineer, and require its removal from the Site. Supply new material conforming to the specified requirements at no additional cost to Owner.

B. Storage of Materials:
   1. Store materials so as to preclude the inclusion of foreign materials.
   2. Store in accordance with manufacturer's recommendations in a clean, dry, well-ventilated area.
   3. Store materials out of direct sunlight and at a temperature of not less than 40 degrees F.

C. Handling:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until necessary preparatory Work has been completed and installation will start immediately.
   3. Do not expose combustible or sensitive material to excessive heat or open flame.
   4. Materials shall be used in the Work only when the material being incorporated into the Work bears the same name and formulation as the container or package in which it is contained.
   5. Contractor shall not change containers or use material from unmarked or incorrectly labeled containers.
   6. Failure to comply with this requirement will be cause for the Engineer to require the product to be removed from the Site and the area wherein the product has been incorporated to be removed and rebuilt with material complying with the specified requirements. This requirement shall govern even if Contractor certifies or proves that the material was appropriate for incorporating into the Work.

1.6 JOB CONDITIONS

A. Environmental Conditions:
   1. Proceed with the cementitious coatings Work only when weather conditions will permit unrestricted use of materials and quality control of the Work being installed, complying with this Section's requirements and with the recommendations of the interior ceiling finish systems materials manufacturer.
   2. Apply coatings only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
   3. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
   4. Proceed only when Contractor and the installer are willing to guarantee the Work as required and without additional reservations and restrictions.

1.7 SCHEDULING

A. Proceed with and complete the Work only when materials, equipment and workers required for the installation of the cementitious coatings Work are at the Site and have sufficient materials and resources to complete the Work in a manner which shall reveal no inconsistencies of texture, color or allowable tolerance in the finished Work greater than that which has been approved on the sample panel by Engineer.

B. Protection:
   1. Do not allow cementitious coatings Work to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining materials.
   2. Draw all color break lines accurately and to the tolerances specified.
   3. Protect materials against damage by construction traffic.

1.8 WARRANTY

A. Contractor shall furnish an additional written warranty signed by the manufacturer, installer and Contractor, agreeing to replace cementitious coatings Work which fail in materials or workmanship within five years of the date of Final Acceptance.

PART 2 - PRODUCTS

2.1 CEMENTITIOUS COATINGS

A. Polymer-Modified Cementitious Coating: Containing portland cement, polymer, and hydrated lime or aggregates.

B. Product and Manufacturers: Provide one of the following
   1. Euclid Chemical Company, Tamms Industries; Tamoseal.
   2. Gemite Products, Inc.; Cem-Kote ST
   3. BASF Building Systems; Thoroseal with Acryl 60.
   4. Or Equal.

C. Performance Requirements: Comply with the following:
   1. Compressive Strength: Not less than 3500 psi at 28 days according to ASTM C 109/C 109M.
   2. Tensile Strength: Not less than 350 psi at 28 days according to ASTM C 109/C 109M.
   3. Flexural Strength: ASTM C 348: 810 psi at 28 days

4. Adhesion: <Insert value and test method>.
5. Permeance: ASTM E 514 (after coating leaking wall):
   a. Extent of damp area: 72 hours 0.0%
   b. Maximum Leakage: 1 hour: None
   c. Leakage Rate: ml/hr: None
   d. Permeance Rating: Excellent
6. Fungus Growth: Fed Test 141 Method 6272: Resistant
7. Weatherometer ASTM G96: 6,000 Hours, No crazing, cracking, chipping or flaking. Light chalking and color change. No other deterioration

D. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

E. Colors: As selected by Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and the installer shall examine the substrates to receive cementitious coatings Work, and the conditions under which the Work is to be performed, and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the cementitious coatings. Do not proceed with the cementitious coatings Work until unsatisfactory conditions have been corrected by Contractor.

B. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.

D. Cementitious Surfaces: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.
   1. Cracks Larger Than 1/32 Inch: Cut out static cracks, voids, or honeycombing larger than 1/32 inch and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

3.3 APPLICATION

A. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.
   1. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated surface dry at time of application.
   2. Brushes: Use tampico or masonry brushes best suited for material being applied.
   3. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.

B. Apply each material at not less than manufacturer's recommended spreading rate. Provide total cured material thickness indicated or as recommended in writing by manufacturer.

C. Brush Application: Brush-out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.

D. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

3.4 FIELD QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coating operations are being conducted:
   1. Owner will engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   2. Engineer may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 COATING SCHEDULE

A. General: Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.

B. Above-Grade Concrete: Two finish coats with total cured thickness not less than 40 mils
   1. First Coat: Apply polymer-modified cementitious coating material at the rate of 2 lb/sq. yd. to achieve a total cured thickness of 25 mils .
   2. Second Coat: Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. to achieve a total cured thickness of 15 mils.

END OF SECTION 09 9726

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SECTION 10 1100

VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install visual display surfaces.

B. Related Sections:
   1. Section 09 2116, Gypsum Board Assemblies.
   2. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Architectural Manufacturers Association, (AAMA).
      a. AAMA 611, Voluntary Standards for Anodized Architectural Aluminum.
      b. AAMA 2603, Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coating on Aluminum Extrusions and Panels.
   2. American National Standards Institute, (ANSI).
      a. ANSI A117.1, Guidelines for Accessible and Useable Buildings and Facilities - Providing Accessibility and Usability for Physically Handicapped People (ICC/ANSI A117.1-1998).
   3. American Society for Testing Materials, (ASTM).
      a. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. Ohio Building Code.
   5. National Association of Architectural Metal Manufacturers, (NAAMM).
      a. NAAMM - Metal Finishes Manual for Architectural and Metal Products.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Furnish all visual display surfaces from one manufacturer for the entire project. In addition to the requirements of this Section, comply with manufacturer's instructions and recommendations for all phases of the Work, including preparation of substrate, installation of grounds and anchors, and application of materials.

B. Requirements of Regulatory Agencies:
   1. Codes: Comply with applicable provisions of the following:
      a. Ohio Building Code.
      b. ANSI A117.1 and Americans with Disabilities Act of 1990 Title II ADAAG.
   2. Fire-Test-Response Characteristics: Provide vinyl-coated tackboards with the following surface-burning characteristics as determined by testing assembled materials composed of facings and backings identical to those required in this Section in accordance with the requirements of ASTM E 84 by a testing and inspecting agency acceptable to authorities

having jurisdiction. Identify vinyl-coated tackboards with appropriate markings of applicable testing and inspecting agency.
a. Flame Spread: 25 or less.
b. Smoke Developed: 10 or less.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Drawings for each type of visual display surface unit. Include full-scale sections of typical trim members and dimensioned elevations. Show anchors, grounds, reinforcement, accessories and installation details.
2. Product Data:
a. Submit for approval manufacturer's technical data and installation instructions for each material and component part. Include methods of installation for each type of substrate to receive units. Transmit copy of each instruction to the installer.
3. Samples:
a. Samples for each type and color of visual display surface, trim and accessories are required. Provide 4-inch square samples of sheet materials and 4-inch lengths of trim members. Engineer'S review of samples will be for color, pattern and texture only. Compliance with all other requirements is the exclusive responsibility of Contractor.

B. Closeout Submittals: Submit the following:
1. Warranty Documentation: Manufacturer's warranty.

1.5 WARRANTY

A. Porcelain-Enamel Marker-board Warranty: Submit a written warranty executed by manufacturer agreeing to replace porcelain enamel markerboards that do not retain their original writing and erasing qualities or become slick and shiny, or exhibit crazing, cracking, or flaking within the specified warranty period, provided the manufacturer's written instructions for handling, installation, protection, and maintenance have been followed.
1. Warranty Period: Life of the facility.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Porcelain-On-Metal Markerboards: Balanced, high-pressure laminated, 3-ply construction, with facing sheet, core and backing.
1. Porcelain Finish: Porcelain enamel over ground coat on writing surface with seal coat on reverse side. Furnish standard colors and special projection surface.
2. Face Sheet: Enameling steel, 24 gage.
3. Core: Plywood or hardboard, 3/8-inch thick.
4. Backing Sheet: Manufacturer's standard 0.015-inch aluminum sheet.
5. Color: Manufacturer's standard colors.
6. Products and Manufacturers: Provide one of the following:
a. 500 Series p3 Markerboard by PolyVision Corporation.
b. Series 185 LCS Markerboard by Claridge Products and Equipment, Incorporated.
c. Or equal.

B. Plastic Impregnated Cork Tackboards:
   1. Seamless sheet, 1/8-inch thick with washable vinyl finish, of ground natural cork compressed with resinous binder and integral color throughout entire thickness and laminated to burlap backing. Furnish rigid panels by factory-laminating under pressure to 3/8-inch thick plywood or hardwood backing.
   2. Color: Manufacturer's standard colors.
   3. Products and Manufacturers: Provide one of the following:
      a. Vinyl Plus Tackboard by PolyVision Corporation.
      b. No. 380A Tackboard by Claridge Products and Equipment, Incorporated.
      c. Or equal.

C. Markers: Manufacturer's standard set of 12 assorted colors specifically made for use with specified markerboard. Provide one set for each markerboard.

D. Combination Markerboard and Tackboard:
   1. Same materials specified above.
   2. Mounted as one unit.
   3. Products and Manufacturers: Provide one of the following:
      a. 500 Series p3 Markerboard and Tackboard, Type B by PolyVision, Corporation.
      b. Type BR Markerboard/Tackboard by Claridge Products and Equipment, Incorporated.
      c. Or equal.

E. Trim and Accessories:
   1. General: Fabricate frames and trim of not less than 0.062-inch thick aluminum alloy. Size and shape as specified, to suit type of installation. Provide straight, single-length units wherever possible and keep joints to a minimum. Miter corners to a neat, hairline closure.
      a. Provide manufacturer's standard wide trim units, approximately 1-1/2-inch wide, slip-on type.
      b. When structural support accessories are required for markerboards and tackboards, in addition to normal trim, provide the required additional support or modify trim to provide the necessary support.
   2. Markertrough: Finish continuous aluminum markertroughs for each markerboard, using box type, with slanted front and cast aluminum end closures.
   3. Finishes:
      a. General: Comply with NAAMM's “Metal Finishes Manual for Architectural and Metal Products” for recommendations relative to applying and designating finishes.
      b. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010-mm or thicker) complying with AAMA 607.1.

F. Fabrication:
   1. Assembly: Provide factory-assembled markerboards, tackboards and combination markerboard and tackboard units.
      a. Make joints only between markerboard and tackboard.
      b. Provide mullion trim at joints between markerboard and tackboard.
      c. Markerboards: 4-feet 0-inches high by 4-feet 0-inches long.
      d. Tackboards: 4-feet 0-inches high by 4-feet 0-inches long

e. Combination Markerboards and Tackboards: 4-feet 0-inches high by 4-feet 0-inches long (4-feet 0-inches high by 2-feet 0-inches long for each section of the combination markerboard and tackboard).

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and his installer shall examine substrate and conditions under which the visual display surfaces Work is to be performed and notify Engineer, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. Install display surfaces in locations and mounting heights as directed by Engineer and in accordance with the manufacturer's instructions. Provide all grounds, clips, backing materials, brackets and anchors, trim, and accessories for a complete installation.

B. Deliver factory-built vinyl display surfaces completely assembled in one piece without joints, whenever possible. Where dimensions exceed panel size, provide two or more pieces of equal length, as acceptable to Engineer. When overall dimensions require delivery in separate units, pre-fit at the factory, disassemble for delivery, and make final joint at a Site. Use splines at joints to maintain surface alignment and smooth joints.

C. Install units with concealed hangers plumb and level, in accordance with the manufacturer's printed instructions.

D. Coordinate job-assembled units with grounds, trim and accessories. Join all parts with neat, precision fit.

END OF SECTION 10 1100

SECTION 10 1400

SIGNAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install signage.
      a. General Contractor shall be responsible for all signage throughout the Project as shown and as specified herein.
   2. Extent of signage is shown and, where indicated, as specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the signage.
   2. Each prime Contractor shall review installation procedures under other Sections of its Contract, and in other Contracts, and coordinate the installation of items that must be installed with, or before, the signage.
   3. Coordinate adhesives and fasteners with mounting surfaces. Review other Sections in order to ensure compatibility of identification device mounting accessories for the various surfaces.

C. Related Sections:
   1. Section 09 9100, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. Aluminum Association, (AA).
      a. AA SAA-46, Standards for Anodized Architectural Aluminum.
      b. AA DSA-45, Designation System for Aluminum Finishes.
   2. American National Standards Institute, (ANSI).
      a. ANSI A13.1 Scheme for the Identification of Piping Systems.
      b. ANSI A117.1, Accessible and Usable Buildings and Facilities.
      c. ANSI Z535.1, Safety Color Code.
      d. ANSI Z535.2, Environmental and Facility Safety Signs.
      e. ANSI Z535.3, Criteria for Safety Symbols.
      f. ANSI Z535.4, Product Safety Signs and Labels.
      g. ANSI Z535.5, Accident Prevention Tags (for Temporary Hazards).
   3. American Society for Testing and Materials, (ASTM).
      a. ASTM A 167, Specification for Stainless and Heat-Resisting Chromium -Nickel Steel Plate, Sheet, and Strip.
      b. ASTM B 26, Specification for Aluminum-Alloy Sand Castings.
      c. ASTM B 584, Specification for Copper Alloy Sand Castings for General Applications.
      d. ASTM E 527, Practice for Numbering Metals and Alloys (UNS).
   4. Chemical Abstract Services, (CAS).

a. CAS Registry Numbers for Specific Chemical Identity.

5. Copper Development Association, (CDA).
   a. CDA, Properties of Cast Copper Alloys.
6. National Fire Protection Association, (NFPA).
   a. NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
7. Occupational Safety and Health Administration, (OSHA).
   a. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.1200, Hazard Communication Standard.
   b. OSHA 1970, Title 29, Code of Federal Regulations Part 1910, Subpart Z, Toxic and Hazardous Substances.
   c. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.144, Safety Color Code for Marking Physical Hazards.
   d. OSHA 1970, Title 29, Code of Federal Regulations Part 1910. 145, Specification for Accident Prevention Signs and Tags.
8. Public Law 101-36, The Americans with Disabilities Act of 1990, Title 28, Appendix A, Code of Federal Regulations Part 36, Accessibility Guidelines for Buildings and Facilities - ADAAG.

1.3 QUALITY ASSURANCE

A. Signage Manufacturers:
   1. Engage firms specializing in the production of the types of products specified, in compliance with specified standards, with a documented record of successful in-service performance, and who can provide sufficient production capacity to avoid delaying the Work.
   2. Submit name and experience record of manufacturers to Engineer.

B. Component Supply and Compatibility:
   1. Obtain each separate type of identification device from a single supplier and from a single manufacturer.
   2. Colors shall be brilliant, distinctive shades, matching the safety colors specified in ANSI Z535.1 and OSHA 1910.144.

C. Requirements of Regulatory Agencies:
   1. Permanent rooms and spaces, and directional and informational signage where specified as accessible to people with disabilities shall comply with ANSI A117.1 and ADAAG.
   2. All right-to-know labels, signs and tags shall use NFPA 704 “Diamond” hazard identification systems and shall comply with OSHA 1910.1200 and OSHA Subpart Z.
   3. All accident prevention signs and tags shall comply with OSHA 1910.145.
   4. All health, safety and warning signs shall comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3 and OSHA 1910.144 and 1910.145, unless otherwise specified. The colors shall be those of opaque glossy samples as specified in Table 1 of ANSI Z535.1. Safety symbol pictograms shall be incorporated into each sign, in addition to text.

1.4 SUBMITTALS

A. Samples: Submit the following:
   1. Each color and finish of exposed materials and accessories required for signage.
   2. full-size sample of each type of permanent room and space identification sign and informational and directional sign incorporating all features specified; pipeline

identification sign and mounting accessories; equipment and structure nameplate, valve tags and accessories; and right-to-know signs, labels and tags. Stamp valve tag with information shown on valve schedules. Information on the type of coding system will be furnished to Contractor by Engineer.

3. Actual full-size representative sample of each individual-type letter and number specified, demonstrating alphabetic style, material, color and finish specified.
4. Engineer's review of samples will be for color and texture only. Compliance with all other requirements is the responsibility of Contractor.

B. Shop Drawings: Submit the following:
1. Copies of manufacturer's technical data for each product specified including fabrication and erection information for all signage. Show anchorages and accessory items. Furnish location template drawings for items supported or anchored to permanent construction.
2. Complete selection of each specified manufacturer's standard and custom colors, alphabetic styles, graphic layouts and pictograms. Include full-size graphic layouts for plaques, individual dimensional letters and numbers and other items where final graphic appearance must be established prior to fabrication, incorporating all required graphic features specified or shown.
3. Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on plans showing locations of all required exit signs based on measurements taken at the Site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for non-interference with other Work and as required by governing authorities having jurisdiction at the Site.

1.5 PROJECT CONDITIONS

A. Field Measurements:
1. Verify dimensions in areas of installation. Take measurements at the Site before fabrication and indicate dimensions on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to dimensions established for signage Work.

B. Scheduling:
1. Coordinate the delivery of templates, instructions and directions for installation of anchorage devices with other Work to avoid delay.

1.6 MAINTENANCE

A. Extra Materials:
1. Furnish extra materials from the same manufactured lot as the materials installed.
2. Contractor shall furnish the following spare parts and accessories:
    a. For every 20 pipeline identification signs installed:
        1) One complete mounting assembly.
    b. For every 20 nameplates installed:
        1) One complete nameplate mounting assembly.
    c. For every 20 valve identification tags:

1) One stainless steel cable and splice and store in a secure area at the Site as directed by Owner.

3. Do not provide partial containers or packages of materials. Round-up quantities to furnish only complete, unopened and undamaged containers and packages; with legible labels accurately representing contents of container or package indicating compliance with approved Samples and Shop Drawings, and matching materials actually installed.
   a. All spare parts and accessories shall be suitably boxed and marked for storage and reordering.

B. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used on this Project, with calculations establishing quantity of extra materials to be furnished to Owner.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Details for signage shown, such as alphabet representation, letter spacing, borders designs, and other graphic features, are generic and intended to establish text, general positions and symbols only.
   2. Contractor shall submit for approval complete, camera-ready, color graphic layouts based on specified requirements and recommendations from manufacturer.

B. Allowable Tolerances:
   1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16-inch measured diagonally.

2.2 PANEL SIGNS – ROOM IDENTIFICATION, INFORMATION, ENTRY, AND DIRECTIONAL

A. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast MP and FG ADA System and Custom Design ADA Series, by Best Sign Systems, Inc.
   2. Blast Etched Fiberglass and Blast Etched Melamine Signs, by Visigraph Corporation.
   3. Or equal.

B. Panel Signs – Room Identification, Information, Entry, and Directional:
   1. Product Description: Provide unframed signs, surface-etched, 1/32-inch raised tactile lettering and pictograms, sandblasted on an opaque sheet.
   2. Materials:
      a. Interior Signs: Three-ply, self-extinguishing melamine plastic.
      b. Exterior Signs: One-piece fiberglass.
   3. Size and Thickness: 0.125-inch thick; eight inches by eight inches with 1/2-inch radiused corners.
   4. Graphics and Text: White, Standard Helvetica Medium characters and matching arrow type-face; upper and lower case letters, one-inch high capitals and, in addition, Grade 2 Braille alphabet for room designation, directional, entry, and information signs.
   5. Colors and Contrast: Background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast by at least 70 percent with their background as determined by ADA formula in ADAAG Appendix A4.30.5.

2.3 PANEL SIGNS – HEALTH, SAFETY, WARNING, FLOOR LOADING, AND FIRE EXTINGUISHER LOCATION SIGNS

A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.

B. Size and Thickness: 0.125-inches thick; 10-inches by 14-inches, unless otherwise specified.

C. Graphics and Alphabet: Standard Helvetica Medium alphabet and matching arrow type-face; upper and lower case 1-inch high capitals and, in addition, Grade 2 Braille alphabet message designations and other text.

D. Exposure: Recommended by the manufacturer for both indoor and outdoor use and with an upper service temperature limit of 190°F. Average durability for outdoor use shall be 15 years.

E. Safety Instruction Signs: Standard color of the background shall be white; and the panel, green with white letters. All letters used against the white background shall be black. Provide 2 to be used throughout the project.

F. Caution Signs: Standard color of the background shall be yellow; and the panel, black with yellow letters. Provide 2 to be used throughout the project.

G. No Smoking Signs: Standard color of the background shall be white. All letters used against the white background shall be red. Provide 2 to be used throughout the project.

H. Biohazard Signs: Standard color of sign background shall be white; panel shall be black with white letters. Sign shall include red international biohazard pictogram on white background.

I. Floor Loading Signs: Standard color of the background shall be white; and the panel blue with white letters. All letters used against the white background shall be black. Provide 1 sign each Room.

J. Fire Extinguisher Location Signs (surface-mounted units only): Standard color of the background shall be red with white letters. Each sign shall incorporate an international fire extinguisher pictogram and a directional arrow indicating location of fire extinguisher. Provide 1 sign for each fire extinguisher.

K. NFPA Chemical identification Plaque: Provide NFPA diamond signs complying with NFPA Standard 704. Provide 3 signs to be used throughout the project.

L. Auxiliary Products:
   1. Mounting Brackets: Provide manufacturer's standard mounting brackets for hanging, projected or double-sided signs.

M. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast Word and Picture Series by Best Manufacturing Sign Systems, Incorporated.
   2. Or equal.

2.4 PIPELINE IDENTIFICATION SIGNS

A. Pipeline Identification Signs:

1. Lettering of Titles:
   a. Letter size shall be as indicated in the following table:

LETTER SIZE TABLE

Outside Diameter of Pipe or Covering*	Size of Legend Letters
3/4-inches to 1-1/4 inches	1/2-inches
1-1/2-inches to 1-7/8--inches	3/4-inches
2-inches to 5-7/8-inches	1-1/4-inches
6-inches to 9-7/8-inches	2-1/2-inches
10-inches and Over	3-1/2-inches

*Outside diameter shall include pipe diameter plus insulation and jacketing.

   b. Text and symbols shall be Standard Helvetica Medium, all upper case. Signs shall include text with separate arrow signs indicating direction of flow and be located as specified in Part 3 of this Section.
2. Pipe Marker Materials:
   a. General: The following are applicable to all types of pipe markers furnished under this Section:
      1) Provide pipe markers with ultraviolet light-resistant, sealed, subsurface color graphics, recommended by sign manufacturer, suitable for both indoor and outdoor use.
      2) Pipe markers shall be resistant to abrasion, chemical reagents, and physical agitation such as washdowns and wind.
      3) Provide manufacturer's full selection of standard and custom sizes and graphics.
      4) Where manufacturer has established minimum order quantities for custom units provide minimum order quantities at no additional cost to Owner.
   b. Materials: Provide the following at Contractor's option, suitable for outside diameter of the associated pipe and pipe covering:
      1) Adhesive, Wrap-Around Pipe Markers: Adhesive pipe markers shall be coiled construction, 0.006-inch total thickness, PVF over laminated polyester, with peel-off backing. Suitable for service temperature ranging from -40 degrees F to 230 degrees F.
      2) Snap-on Pipe Markers: Snap-on pipe markers shall be cylindrically coiled, printed plastic sheets. Pipe marker total thickness for pipe and pipe covering from 3/4-inch to 2-3/8-inch outside diameter shall be not less than 0.020-inch. Pipe marker total thickness for pipe and pipe covering from 2.5-inch through six-inch outside diameter shall be not less than 0.030-inch. Suitable for service temperature ranging from -40 degrees F to 180 degrees F.
      3) Strap-on Pipe Markers: Provide strap-on pipe markers where pipe diameter is large enough to preclude overlap of pipe marker material around the circumference of the pipe. Strap-on pipe markers shall be flat, printed plastic sheets, not less than 0.020-inch total thickness, constructed to be attached to the pipe with bands. Suitable for service temperature ranging from -40 degrees F to 180 degrees F. Provide each pipe marker with two 1/4-inch wide band straps of nylon, plastic, or stainless steel, lengths as required by circumference of pipe and pipe covering. Provide manufacturer's recommended banding tools for banding.
3. Legend for Pipeline Identification Signs: Pipeline identification signs shall have the following text or abbreviations in the color combinations designated to identify the pipeline service.

TABLE 10 1400-A,
SCHEDULE OF PIPELINE IDENTIFICATION SIGNS*

Pipeline Legend	Lettering Color	Background Color	Spacing (feet)
WATER			
Potable Water	White	Blue	10
Cold Water	White	Blue	10
Domestic Hot Water	Black	Yellow	10
Tepid Water	White	Green	10
City Water	White	Green	10
Concentrate Water	Black	Orange	10
Filtered Water	White	Green	10
Permeate Water	White	Green	10
Blended Water	White	Green	10
Fire Water	White	Red	10
Sprinkler Water	White	Red	10
AIR AND GAS			10
Natural Gas	White	Brown	10
CHEMICALS			10
Acidic Cleaner	Black	Orange	10
Antiscalant	Black	Orange	10
Basic Cleaner	Black	Orange	10
Caustic Soda	Black	Orange	10
Chlorine Liquified	Black	Orange	10
Sodium Bisulfite	Black	Orange	10
PROCESS			10
Floor Drains	Black	Gray	10
Chemical Storage Tank Drains	Black	Orange	10
Chemical Storage Tank Overflow	Black	Orange	10
Storm Drains	White	Gray	10
Sump Drains	White	Gray	10
Wastewater	Black	Orange	10
VENTS			10
Break Tank Vent	Black	Orange	10

*Where shown or specified, the legend for blowoff, drain, metering, sump, vent and similar pipelines shall also include the equipment, structure or identification number to which the service applies. The number shall be provided in the same color as the service line.

B. Products and Manufacturers: Provide one of the following:
   1. Custom B-689 High Performance Pipe Markers by Brady USA, Incorporated Signmark Division.
   2. Or equal.

2.5 EQUIPMENT NAMEPLATES

A. Equipment Nameplates:
   1. Titles for Equipment:
      a. Titles shall be provided on all equipment using 1-inch high letters. Where more than one piece of the same type of equipment is shown or specified to be titled, the items shall be numbered consecutively as shown; for example Pump No. 1, Pump No. 2, etc., or as shown in the following schedule.
      b. Text and symbols shall be Standard Helvetica Medium, all upper case.
   2. Left-justify multiple line titles.
   3. Size and Material: Provide the following:
      a. Size: 1-1/2 inches by 4-inches, minimum.
      b. Material: Type 304 stainless steel; screen printed; 0.015-inches thick.

B. Products and Manufacturers: Provide one of the following:
   1. Screen Printed Stainless Steel Equipment Tags by Brady USA, Incorporated Signmark Division.
   2. Or equal.

2.6 FABRICATION

A. Shop Assembly:
   1. Fabricate and preassemble items in the shop to the greatest extent possible.
   2. Disassemble units only to the extent necessary for shipping and handling limitations.
   3. Clearly mark units for reassembly and coordinated installation.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor and his installer shall examine the substrates and conditions under which the signage are to be installed and notify Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. General:
   1. Install signage and components at the locations shown or, if not shown, as directed by Engineer, securely mounted with concealed very-high-bond acrylic foam tape or mechanical/chemical fasteners where specified. Attach signs to surfaces in accordance with the manufacturer's instructions, unless otherwise shown.
   2. Lightly mark and locate the position of all signage. Obtain Engineer’s approval of all locations before mounting. Install level, plumb, and at the proper height. Repair or replace damaged units as directed by Engineer.
   3. Install very-high-bond acrylic foam tape on back of signage using a full perimeter of specified tape. Leave no gaps in tape perimeter at back of signage; peel off second release liner and press onto surfaces.
   4. Install level, plumb, and at the specified height.

B. Pipe and Equipment Identification Signs, Nameplates and Tags:
   1. The name of the materials in each pipeline and, alongside this, an arrow indicating the direction of flow of fluids, shall be indicated on each pipeline system.

2. Titles shall not be located more than 30 linear feet apart and shall also appear directly adjacent to each side of all walls penetrated by pipeline, adjacent to each side of all valve regulators, flowcheck, strainer cleanouts, and all pieces of equipment. Arrows shall be located at intervals not to exceed 15 linear feet apart.
3. Titles shall identify contents by complete name. Identification title locations shall be determined by Engineer, but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering when they are overhead. Title shall be clearly visible from operating positions especially those adjacent to control valves.
4. Signs on large valves shall be located on or adjacent to the valve itself. Tags for smaller valves shall be attached to bonnet or flange bolts. Do not attach tags or signs to handwheels of valves.
5. Locate nameplates on equipment bases and on structures at readily visible levels in such positions relative to the equipment and structures as to prevent damage to the nameplate.

3.3 PROTECTION AND CLEANING

A. After installation, clean soiled identification device surfaces according to manufacturer's instructions.

B. Protect units from damage until Final Completion by Owner.

END OF SECTION 10 1400

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SECTION 10 2805

TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install toilet and bath accessories Work.
   2. Extent of toilet and bath accessories is shown and specified.

B. Coordination:
   1. Furnish inserts and anchoring devices to be set in concrete or built into masonry and recycled gypsum wallboard for installation of toilet and bath accessories. Refer to concrete and masonry Specifications for installation of inserts and anchorage devices.
   2. Coordinate toilet and bath accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of toilet and bath accessories
   3. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before toilet and bath accessories Work.

C. Related Sections:
   1. Section 08 7100, Door Hardware.
   2. Section 10 2113, Toilet Compartments.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/ICC A117.1, Accessible and Usable Buildings and Facilities.
   2. NFPA 70, National Electric Code.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide products of the same manufacturer for each type of bath accessory unit and for units exposed in the same areas.

B. Regulatory Requirements:
   1. Comply with the following:
      a. Building code specified in Section 01 4200, References.
      b. Requirements of authorities having jurisdiction
      c. ANSI/ICC A117.1
      d. Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A, to 28 CFR Part 36 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of toilet and bath accessories indicating proposed location for each item.
   2. Product Data:
      a. manufacturer's published literature, technical data, and specifications for each toilet and bath accessory item.
   3. Samples:
      a. Standard and custom color charts for color selection by Engineer. Submit for each item under this Section where color or finish is not specified.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Setting drawings, templates, instructions, and directions for installing anchorage devices in other work.
      b. Instructions for storing and installing materials furnished.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. Components and materials shall be suitable for their intended use and environment.
   2. Stamped names or labels on exposed faces of units are unacceptable.
   3. Provide locks with the same keying for each type of toile and bath accessory units in the Project, where possible. Furnish two keys for each lock.
   4. Electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SURFACE-MOUNTED PAPER TOWEL DISPENSER

A. Products and Manufacturers: Provide one of the following:
   1. No. 0210, by American Specialties, Inc.
   2. B-262, by Bobrick Washroom Equipment, Inc.
   3. Or equal.

B. Requirements:
   1. Size to dispense not less than 400 c-fold towels with interchangeable paper drop.
   2. Construction: Cabinet and door not less than 22-gage stainless steel, No. 4 satin finish, all-welded construction, without mitered corners. Hang door with concealed, full-length stainless steel piano hinge
   3. Provide with tumbler-lockset.

2.3 SURFACE-MOUNTED WASTE RECEPTACLE

A. Products and Manufacturers: Provide one of the following:
   1. No. 0826, by American Specialties, Inc.
   2. B-275, by Bobrick Washroom Equipment, Inc.
   3. Or equal.

B. Construction: Fabricated from not less than 22-gage stainless steel, No. 4 satin finish, all-welded construction, without mitered corners. Top and bottom hemmed, interior liner hooks, 12-gallon capacity.

2.4 SURFACE-MOUNTED SANITARY NAPKIN DISPOSAL UNIT

A. Products and Manufacturers: Provide one of the following:
   1. No. 0473-A by American Specialties, Inc.
   2. No. B-254 by Bobrick Washroom Equipment, Inc.
   3. Model 4722-15 by Bradley Corporation.
   4. Or equal.

B. Requirements:
   1. Fabricate disposal units from not less than 22-gage stainless steel, with flange of one-piece seamless construction without metered corners.
   2. Provide self-closing upper door equipped with full-length stainless steel piano hinge and lift handles on each end.
   3. Trap door shall have hidden stainless steel spring tensioned self-catching lock and be hinged on front face. Provide fold-down stainless steel purse shelf of 22-gage stainless steel.

2.5 Requirements:

1. Dispenser Capacity: Simultaneously dispenses both napkins and tampons:
   a. Napkins: 15 napkins: four-inch by three-inch by 1-1/8-inch.
   b. Tampons: 23 tampons; five-inch; cylinder.
2. Construction: Fabricate units from not less than 16-gage stainless steel, with full-face door, and 18-gage stainless steel body with no exposed fastening devices or spot weld seams. Provide stainless steel door mounted on full-length heavy-duty stainless steel piano hinge with pin tumbler locks.
3. Operation: Gratis.

2.6 TOILET TISSUE DISPENSERS

A. General: Provide toilet tissue dispensers at each water closet.

B. Products and Manufacturers: Provide one of the following:
   1. No. 0697-GAL, by American Specialties, Inc.
   2. B-2840, by Bobrick Washroom Equipment, Inc.
   3. Model 5263, by Bradley Corporation.
   4. Or equal.

C. Multi-roll Toilet Tissue Dispenser and Ash Tray: Fabricate shelf of not less than 18-gage stainless steel, to store and dispense not less than two 4.5-nch by 4.5-inch core tissue rolls. Fabricate flange from a single piece, with seamless construction.

2.7 TOILET SEAT TISSUE DISPENSERS

A. General: Provide surface-mounted toilet seat tissue dispenser at each water closet.

B. Products and Manufacturers: Provide one of the following:
   1. No. 0477-SM, by American Specialties, Inc.

2. B-221, by Bobrick Washroom Equipment, Inc.
3. Model 583, by Bradley Corporation.
4. Or equal.

C. Surface-mounted Toilet Seat Tissue Dispenser: Satin-finish stainless steel. Dispenses 250 single- or half-fold toilet seat covers.

2.8 MIRRORS

A. Accessible Tilt Mirrors:
1. General: Provide accessible tilt mirror above each accessible lavatory.
2. Products and Manufacturers: Provide one of the following:
   a. No. 0535-B, by American Specialties, Inc.
   b. B-293, by Bobrick Washroom Equipment, Inc.
   c. Model 740-1836, by Bradley Corporation.
   d. Or equal.
3. Stainless Steel Frame: Fabricate frame from 20-gage, Type 304L stainless steel, welded and ground smooth, no shelf. Mirrors shall be 1.5 feet by three feet size, with tilting frame tapered from 1.5 inches at bottom to 4.5 inches at top.

B. Custom Sized Angle Framed Mirrors:
1. General: Provide single pane, polished tempered glass mirrors continuous above each non-handicapped lavatory.
2. Products and Manufacturers: Provide one of the following:
   a. Custom Sized 0600-B Mirrors by American Specialties, Inc.
   b. Custom Sized B-290 Mirrors, by Bobrick Washroom Equipment, Inc.
   c. Model 780-2, by Bradley Corporation.
   d. Or equal.
3. Stainless Steel Frames: Fabricate frames from 3/4-inch by 3/8-inch 18-gage, Type 304 stainless steel angle with corners heliarc welded, ground and polished smooth to uniform satin finish. Provide all mirrors installed on concealed hanging brackets that lock onto top and bottom of frame by tamper-proof set screws.

2.9 GRAB BARS

A. General: Provide grab bars where shown. Provide custom specials where required or specified.

B. Products and Manufacturers: Provide one of the following:
1. 3200 P Series custom Type 56 with 54-inch leg and 36-inch leg, by American Specialties, Inc.
2. B-68137.99, by Bobrick Washroom Equipment, Inc.
3. Model 812-2, Type 059 by Bradley Corporation.
4. Or equal.

C. Custom Stainless Steel Grab Bars:
1. Provide stainless steel knurled grab bars, 1.5-inch outside diameter, 16-gage.
2. Mounting: Concealed, with manufacturer’s standard flanges and anchorages for type of installation.
3. Provide custom dimensions specified.

2.10 SURFACE-MOUNTED HORIZONTAL LIQUID SOAP DISPENSER/SHELVES

A. General: Provide surface-mounted liquid soap dispensers, one per lavatory.

B. Products and Manufacturers: Provide one of the following:
   1. No. 0318, by American Specialties, Inc.
   2. B-2014, by Bobrick Washroom Equipment, Inc.
   3. Model 66, 1 by Bradley Corporation.
   4. Or equal.

C. Liquid Soap Dispenser:
   1. Units shall be 20 inches long by 2.5 inches high by 4-5/10 inches wide, with one liquid soap dispensing valve
   2. Capacity: 80 fluid ounces.
   3. Fabricate units of 20-gage stainless steel, with pin-type tumbler locking device. Provide 20-gage stainless steel shelf using one-piece construction, with integral sides. Dispense liquid soap in measured quantity by pump action with stainless steel internal springs, ABS piston, stainless steel push button and internal parts. Cabinet shall have no exposed fastening devices.
   4. Locking: Pin-type tumbler lock.

2.11 MISCELLANEOUS ITEMS

A. Combination Shelf with Utility Hook and Mop Strip:
   1. Products and Manufacturers: Provide one of the following:
      a. No. 1304-A, by American Specialties, Inc.
      b. B-239x34, by Bobrick Washroom Equipment, Inc.
      c. Model 9934, by Bradley Corporation.
      d. Or equal.
   2. Provide 18-gage stainless steel shelf with 3/4-inch lip, five 18-gage stainless steel hook strips, and four mop holders. Shelf shall be 34 inches wide and eight inches deep.

B. Pail Hooks:
   1. Products and Manufacturers: Provide one of the following:
      a. No. 1307-3, by American Specialties, Inc.
      b. B-232X24, by Bobrick Washroom Equipment, Inc.
      c. Model 9943, by Bradley Corporation.
      d. Or equal.
   2. One-piece channel strip fabricated from 20-gage stainless steel. Provide heavy-duty hooks fabricated from 11-gage stainless steel. Shelf shall be 26 inches long with three hooks.

C. Surface-Mounted Soap Dishes:
   1. Products and Manufacturers: Provide one of the following:
      a. No. 7320, by American Specialties, Inc.
      b. B-7680, by Bobrick Washroom Equipment, Inc.
      c. Model 9014-63, by Bradley Corporation.
      d. Or equal.
   2. Material: Drawn, one-piece stainless steel.

D. Undersink Guards:
   1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.

2. Product and Manufacturer: Provide one of the following:
    a. HANDY SHIELD–MAXX, by Plumberex Specialty Products, Inc.
    b. Truebro Lav Guard 2, by IPS Corporation.
    c. Or Equal.
3. Material and Finish: Anti-microbial, molded plastic, white.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which toilet and bath accessories will be installed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install items required to meet accessibility codes in accordance with Laws and Regulations, and ANSI/ICC A117.1.

B. Determine that substrates are completed and ready to accept surface-mounted or recessed accessories.

C. Use concealed fastenings where possible.

D. Provide anchorage devices, fasteners, and other necessary anchorages, and attach accessories securely to walls, floors, and partitions in locations as shown and as required.

E. Install concealed mounting devices and fasteners fabricated of the same material as the accessories as recommended by manufacturer.

F. Install exposed mounting devices and fasteners finished to match the accessories.

G. Provide theft-resistant fasteners for all mountings.

H. Secure and install toilet and bath accessories in accordance with the manufacturer’s instructions for each item and each type of substrate construction.

I. Lock grab bars to concealed mounting plate installed in wall.

3.3 ADJUSTMENT AND CLEANING

A. Adjust toilet and bath accessories for proper operation.

B. After completion of installation, clean and polish all exposed surfaces.

C. Deliver keys and instruction sheets to Owner in accordance with Section 08 7100, Door Hardware.

END OF SECTION 10 2805

SECTION 10 4400

FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all fire protection specialties Work.
   2. Extent of fire protection specialties Work is shown and specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before fire protection specialties.

C. Related Sections:
   1. Section 10 1400, Signage.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL Fire Classification Rating.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide fire protection specialties products from one manufacturer.

B. Regulatory Requirements: Provide fire protection specialties approved and labeled by UL.

1.4 SUBMITTALS

A. Action Submittals:
   1. Product Data: Submit the following:
      a. Manufacturer’s technical data, certification of UL rating, and installation instructions for fire protection specialties.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

A. General: Provide manufacturer’s standard mounting brackets for portable fire extinguishers size as specified.

B. Multi-Purpose Dry Chemical Fire Extinguishers:
   1. Ten-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires, UL rating 4A-60 BC.
   2. Products and Manufacturers: Provide one of the following:
      a. Cosmic Model 10E by J.L. Industries.

b. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrates and conditions under which fire protection specialties will be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Engineer.

3.2 INSTALLATION OF FIRE EXTINGUISHERS

A. When exact locations of fire protection specialties are not shown on Drawings, locate as directed by Engineer.

B. Securely fasten products to structure, square and plumb, per Supplier's instructions. Mounting heights shall be:
   1. Install fire extinguishers with gross weight greater than 40 pounds with top of fire extinguisher no more than 3.5 feet above finished floor.
   2. Install fire extinguishers with gross weight less than 40 pounds with top of fire extinguisher no more than 4.0 feet above finished floor.
   3. Clearance between bottom of fire extinguisher and finished floor shall be at least four inches.

C. Identification Devices: Provide signs level and plumb directly above surface mounted portable fire extinguishers, securely mounted, attached to substrate per sign manufacturer's instructions. Signage shall be per Section 10 1400, Signage.

D. Recharge fire extinguishers provided under this Contract so that most recent inspection date coincides as nearly as possible with date of Substantial Completion. Inform Owner in writing of next required inspection and recharging date.

END OF SECTION 10 4400

SECTION 12 2100

WINDOW BLINDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all window blind Work.
   2. Extent of window blind units is shown.
   3. Types of products required include the following:
      a. Manually-operated horizontal window blinds.
      b. Miscellaneous accessories and materials.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate with the Work of this Section.
   2. Provide inserts and anchoring devices to be set in concrete or built into masonry and gypsum wallboard for installation of window blinds. Coordinate delivery with other work to avoid delay.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. GANA, Glazing Manual.
   2. NFPA 701, Methods of Fire Tests for Flame Propagation of Textiles and Films.
   3. WCMA A100.1, American National Standard for Safety of Corded Window Covering Products.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide all window blinds of each type of blinds required as complete units produced by one manufacturer, including hardware, accessory items, mounting brackets, and fastenings.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Shop Drawings for special window blind components THAT are not fully dimensioned or detailed on manufacturer's product data. Include elevation layout indicating proposed division between window blind units and meeting edges at corners.
      b. Coordinated drawings showing required clearances to window obstructions and other obstructions that would interfere with window blind operation. Coordinate pocket size and mounting with manufacturer's proposed products and show details and all dimensions on Shop Drawings.
      c. Data sheets for wndow blinds proposed for use.

2. Product Data:
3. Manufacturer's published literature, catalog sheets, and specifications for each type of window blind proposed for use.Samples:
    a. Submit six-inch Samples of window blinds in all standard colors for selection by Engineer.
    b. Engineer's review of Samples will be for color and texture only. Compliance with other requirements of the Contract Documents is Contractor's responsibility.

B. Informational Submittals: Submit the following:
1. Certificates:

C. Closeout Submittals: Submit the following:

D. Maintenance Material Submittals: Submit the following:
1. Extra Stock Materials: Furnish extra materials**,** from the same product run as the materials furnished and installed**,** that match the materials installed and that are packaged with protective covering for storage and identified with labels describing contents.
    a. Window Blinds: Full-size units equal to five percent of the quantity installed for each size, color, texture, pattern, and gloss installed, but no fewer than one unit of each size, color, texture, pattern, abnd gloss.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Deliver window blinds in factory packaging, marked with manufacturer, product name, and installation location using same designations indicated on the Drawings.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not install window blinds until construction and wet and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for the Project when occupied for its intended use.

B. Field Measurements: Where window blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Advise Engineer in writing of installation conditions that vary from those required in the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Horizontal Window Blinds:
1. Products and Manufacturers: Provide one of the following:
    a. Riviera 1/2-inch Mini-Blinds, by Levolor Window Fashions, a Newell Rubbermaid Company.
    b. Décor 1/2-inch Solids Mini-Blinds, by Hunter Douglas Contract, Hunter Douglas, Inc.
    c. Or equal.

2. Head Channel: 0.025-inch thick tomized steel, U-shaped one-inch high by 1-9/16-inch wide with flanged edges at top, and coated with a baked-on finish. All hardware shall be enclosed in the metal head.
3. Tilter: 0.042-inch tomized steel with automatically disengaging worm and gear mechanism to eliminate overdrive and prevent strain or damage to window blinds.
4. Tilt Wand: Transparent with hexagonal cross section of 5/16-inch across flats.
5. Drum and Cradle: One for each window blind ladder as follows:
    a. Drum shall be 0.031-inch tomized steel having two holes with rolled edges to anchor barbs on both ladder ends.
    b. Cradles shall be 0.042-inch thick tomized steel, having two holes with rolled edges to guide cords through bottom of head channel without abrasion.
6. Tilt Rod: U-shaped with a circular radius of approximately 1/8-inch designed to achieve minimum torsional deflection. For window blinds greater than five feet wide and less than 6.67 feet long, or greater than 4.583 feet wide and greater than 6.67 feet long tilt rod shall be a solid D-shaped rod with an average cross section of 1/4-inch designed to achieve minimum torsional deflection.
7. End Braces: 0.037-inch thick tomized steel with reinforcing ribs and field adjustable tabs.
8. Installation Brackets: Provide brackets with a rivet-hinged safety locking front cover not less than 0.048-inch thick tomized steel with baked-on finish matching head channel.
9. Intermediate Brackets: 0.050-inch tomized steel installed with window blinds greater than five feet wide and less than 6.67 feet long, or greater than 4.583 feet wide and greater than 6.67 feet long.
10. Ladders (slat supports): Braided polyester yarn designed from maximum strength and flexibility combined with minimum stretch. Rungs shall consist of not less than two crossed cables interbraided with the vertical components. Ladders shall support the slats without visible distortion. Distance between ladders shall not exceed two feet for window blinds up to 6.67 feet long. For window blinds over 6.67 feet long, distance between ladders shall be not greater than 22 inches.
11. Slats: Virgin high magnesium aluminum, alloyed for maximum strength and corrosion resistance. Slats shall be nominally eight-gage, 1/2-inch wide with an elliptical crown formed after coating and curing. Slat ladder support distances shall prevent visible sag or bow after continued use indoors. Slats shall be unperforated.
12. Bottom Rail: 0.031-inch tomized steel formed after coating provided with color-compatible molded plastic ladder and end caps.
13. Lift Cord: Braided of high-strength flexible polyester fiber cord with minimum stretch and maximum abrasion resistance characteristics. Cord shall be of sufficient length, equalized to properly control raising and lowering of window blinds and spaced not more than 3.83 feet between cords.
14. Colors: Complete selection of manufacturer's standard colors. Engineer will select a maximum of three colors for the Work.
15. Accessories: Provide the following:
    a. Pocket installation brackets.
    b. Projection brackets to clear window hardware.
    c. Two-tone slats with neutral white on outside face.

2.2 FABRICATION AND OPERATION

A. Product Safety Standard: Fabricate vertical louver blinds to comply with WCMA A100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.

B. Prior to fabrication, verify actual opening dimensions by accurate Site measurements. Adjust dimensions for proper fit at all openings.

C. Fabricate components of window blinds from non-corrosive, non-staining, non-fading materials which are compatible with each other, and which do not require lubrication during normal expected life. Use dissimilar metals or plastics for contact surfaces which slide against each other in operation of window blinds.

D. Fabricate window blind units to completely fill the openings as shown, from head-to-sill and jamb-to-jamb. For continuous window wall installations, fabricate window blinds so that ends occur only at mullions or other defined vertical separations, unless otherwise shown.

E. Gear all operating equipment for reduction of the ratio of hand-movement to window blind-movement, so that window blinds operate easily and can be set accurately and smoothly.

F. Concealed Components:
   1. Noncorrodible or corrosion-resistant-coated materials.
   2. Rotation-and-Traverse Mechanisms: With permanently lubricated moving parts.

G. Installation Brackets: Constructed for easy removal and reinstallation of blind, for supporting headrail and operating hardware and for bracket positions and blind mounting method indicated.

H. Installation Fasteners: Not less than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

I. Color-Coated Finish: For metal components exposed to view unless anodized or plated finish is indicated. Apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrates and conditions under which the window blinds Work will be installed and notify Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install window blinds where shown and in accordance with manufacturer's instructions. Position units plumb and true, securely anchored in place with proper clips, brackets, and bolts for the type of mounting required.
   2. Locate so exterior vane edges are not closer than two inches from interior faces of glass and not closer than 1.5 inches from interior faces of glazing frames through full operating ranges of blinds, in accordance with GANA Glazing Manual.
   3. Install mounting and intermediate brackets to prevent deflection of headrails.

4. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

B. Divisions between window blinds are allowed only at mullions of continuous windows or openings where more than one window blind for one opening occurs.

3.3 ADJUSTING

A. Adjust window blinds to operate free of binding and malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

A. Prior to Substantial Completion, clean window blind surfaces in accordance with manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and that ensures that window blinds are without damage or deterioration at Substantial Completion.

C. Prior to Substantial Completion, replace damaged window blinds that cannot be acceptably repaired.

END OF SECTION 12 2100

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SECTION 13 3419

METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all professional services, labor, materials, tools, equipment and incidentals as shown, specified and required to design, furnish, and install all metal building systems of the width, eave height, and roof pitch indicated, capable of withstanding specified structural loads and exposure to weather without excessive deflection, or water infiltration, as shown on the Drawings and in accordance with the Specifications.
   2. Included are:
      a. Building into metal building systems required items and providing openings, closures and escutcheons for metal building systems to accommodate the Work under this and other Sections and attaching to the metal building systems all items such as sleeves, hoods, supports, fasteners and all items required, for which provision is not specifically included under other Sections.
   3. Extent and basic layout of metal building systems work is shown on the Drawings.
   4. Types of products required include the following:
      a. Primary framing system.
      b. Secondary framing system.
      c. Glass-fiber blanket roof and wall insulation.
      d. All auxiliary system components and miscellaneous accessories, fasteners, trim, framed openings, flashing closures, base moldings, gutters, downspouts, vapor retarders and all other items not specified under this or other Sections, but required to provide a completely watertight and functioning building.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the metal building systems.
   2. Coordinate the locations of equipment, piping, heating and ventilating ductwork, electrical conduit, and similar items in order to provide required clearances and supports for such items without modification of metal building system components at the Site.

C. Related Sections:
   1. Section 08 1116, Aluminum Doors and Frames.
   2. Section 08 3323, Overhead Coiling Doors.
   3. Section 08 7100, Door Hardware.
   4. Section 08 9000, Louvers and Vents.
   5. Section 09 9100, Painting.
   6. Section 26 0526, Grounding.
   7. Section 41 2200, Cranes and Hoists.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. AAMA/WDMA/CSA 101/I.S.2/A440, Standard/Specification for Windows, Doors, and Unit Skylights.
2. AAMA 701/702, Combined Voluntary Specification for Pile Weatherstripping and Voluntary Specification for Replacement Fenestration Weatherseals.
3. AAMA 2603, Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
4. AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts, approved by RCSC.
5. AISC, AISC 360, Specification for Structural Steel Buildings.
6. AISI, AISI S100, North American Specification for the Design of Cold-Formed Steel Structural Members.
7. Architectural Metal Products Division of NAAMM, Metal Finishes Manual for Architectural and Metal Products.
8. ANSI A250.4, Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors, and Hardware Reinforcings.
9. ANSI A250.8, Standard Steel Doors and Frames.
10. ANSI/SDI A250.10, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
11. ASCE 7, Minimum Design Loads for Buildings and Other Structures.
12. ASTM A36/A36M, Specification for Carbon Structural Steel.
13. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
14. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
15. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
16. ASTM A325, Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
17. ASTM A475, Specification for Zinc-Coated Steel Wire Strand.
18. ASTM A500/A500M, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
19. ASTM A529/A529M, Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
20. ASTM A563, Specification for Carbons and Alloy Steel Nuts.
21. ASTM A572/572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
22. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
23. ASTM A755/A755M, Specification for Sheet Steel, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
24. ASTM A792/A792M, Specification for Sheet Steel, 55% Aluminum-Zinc Alloy Coated by the Hot-Dip Process.
25. ASTM A992/A992M, Specification for Structural Steel Shapes.
26. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
27. ASTM A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
28. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

29. ASTM B695, Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
30. ASTM C423, Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
31. ASTM C920, Specification for Elastomeric Joint Sealants.
32. ASTM C991, Specification for Flexible Fibrous Glass Insulation for Metal Buildings.
33. ASTM C1136, Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
34. ASTM D523, Test Method for Specular Gloss.
35. ASTM D4214, Test Method for Evaluating Degree of Chalking of Exterior Paint Films.
36. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.
37. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials.
38. ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
39. ASTM E136, Test Method for Behavior of Materials in a Vertical Tube Furnace at 750^0 C.
40. ASTM E283, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
41. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
42. ASTM E331, Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
43. ASTM E1646, Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
44. ASTM E1680, Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.
45. ASTM E2190, Specification for Insulating Glass Unit Performance and Evaluation.
46. ASTM F436, Specification for Hardened Steel Washers.
47. AWS D1.1/D1.1M, Structural Welding Code-Steel.
48. AWS D1.3/D1.3M, Structural Welding Code-Sheet Steel.
49. BMHA Standards.
50. FEMA 320, Taking Shelter From the Storm: Building a Safe Room for Your Home or Small Business.
51. FEMA 361, Design and Construction Guidance for Community Safe Rooms.
52. International Accreditation Service, Inc (IAS), AC472, Accreditation criteria for Inspection Programs for Manufacturers of Metal Building Systems.
53. MBMA, Metal Building Systems Manual.
54. NFPA 80, Standard for Fire Doors and Other Opening Protectives.
55. NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
56. SMACNA, Architectural Sheet Metal Manual.
57. SSPC, Steel Structures Painting Manual Vol. 2.
58. U.L. Standard for Safety – UL 10C, Positive Pressure Fire Tests of Door Assemblies.
59. U.L. Standard for Safety - UL 580, Tests for Uplift Resistance of Roof Assemblies.

1.3 TERMINOLOGY

A. Terminology used in this Specification shall comply with MBMA's, "Metal Building Systems Manual" for definitions of terms for metal building systems construction, and the following:
   1. The term "bay spacing" shall mean the dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured perpendicular to end wall (outside face of end wall girt).

2. The term “building length” shall mean the dimension of the building measured perpendicular to main framing from end wall to end wall (outside face of girt to outside face of girt).
3. The term “building width” shall mean the dimension of the building measured parallel to main framing from sidewall to sidewall (outside face of girt to outside face of girt).
4. The term “clear span” shall mean the distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame, or knee).
5. The term “clear height under structure” shall mean the vertical dimension from finished floor to lowest point of any part of primary or secondary structure, not including crane supports, located within clear span.
6. The term “eave height” shall mean the vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer’s Qualifications:
      a. Metal building system shall be the product of a recognized metal building systems manufacturer who has been in practice of manufacturing metal buildings of the size and complexity of the building shown on the Contract Drawings, for a period no less than five years. The manufacturer shall be chiefly engaged in the practice of designing and fabricating metal building systems and shall be a member of MBMA and be accredited per the requirements of IAS AC472.
   2. Professional Engineer:
      a. Contractor or metal building system manufacturer shall retain a registered professional engineer legally qualified to practice in the same state as the Site. Professional engineer shall have at least five years’ experience in designing metal building systems.
      b. Responsibilities include:
         1) Reviewing metal building system performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to Engineer by Contractor.
         3) Preparing or supervising preparation of design calculations and related Shop Drawings.
         4) Signing and sealing all design calculations and Shop Drawings.
         5) Certifying that:
            a) Design of metal building systems has been performed in accordance with performance and design criteria stated in the Contract Documents, and
            b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
   3. Installer:
      a. Engage a single installer skilled, trained and with documented experience in the erection of metal building systems, who is acceptable to the metal building system manufacturer, and with specific skill and successful experience in the erection of the types of components required.
   4. Testing Laboratory:

a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
b. Testing laboratory shall comply with the requirements of Section 01 4529.13, Testing Laboratory Services Furnished by Contractor, and demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E329.

5. Welding:
a. Qualify procedures and personnel according to AWS D1.1/D1.1M and AWS D1.3/D1.3M, as applicable.
b. Submit certification that each welder employed on or to be employed for the Work possesses current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.

B. Component Supply and Compatibility:
1. Obtain all metal building system components through a single source and from a single manufacturer.
2. Metal building system manufacturer shall review and approve, or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by metal building system manufacturer.

C. Regulatory Requirements:
1. Fabricate and label structural framing to comply with material verification and special inspection requirements of the governing Building Code and Authorities Having Jurisdiction at the Site.

D. Pre-installation Conference:
1. Prior to erection of metal building system components and associated Work, Contractor shall schedule and meet at the Site with the metal building system erector, the installer of each component of associated Work, the installers of substrate construction to receive the metal building systems Work, the installers of other Work in and around metal building system that follows the metal building system Work, including mechanical Work, Engineer and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the metal building system Work, including but not necessarily limited to, the following:
a. Review Project requirements and the Contract Documents.
b. Review required submittals, both completed and yet to be completed.
c. Review status of foundation work, including approval of surface preparations, structural loading limitations and similar considerations.
d. Review construction schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
e. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
f. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
g. Review procedures needed for protection of metal building systems during the remainder of the construction period.
h. Review required inspection, testing, and certifying procedures.

2. Record the discussions of the conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
3. Record all revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.
4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.5 SUBMITTALS

A. Action Submittals:
1. Shop Drawings:
a. Submit foundations loads and anchor bolt plans in advance of erection drawings.
1) Drawings showing all vertical and horizontal reactions on foundation. Include direction and location of each load application.
2) Include diameter, projection, and a plan showing location relative to column center line of all anchor bolts required to attach metal building to foundation. Column center line numbering shall be as shown on the Drawings. Plans shall show location of Project north.
3) Completely dimensioned plans, elevations and cross-sections of the metal building system completely coordinated with all required equipment and building service clearances. All details shall be drawn at a scale of not less than 1-1/2 inches equal to 12 inches. Accurately locate, show and dimension the following:
4) Complete erection drawings showing structural framing system including sidewall, endwall, roof framing, and the center lines of the bottom of all columns. Plans shall show the location of Project north. Show complete fabrication of primary and secondary framing. Indicate standard designation, configuration, sizes, spacing, and location of girts and purlins, including framing around all door and window openings. Show the location, size, and connection details for diagonal bracing or portal frames for walls and roof. Include transverse cross-sections.
5) Provide details of all standard and modified steel connections indicating all shop welded, field welded, and bolted connections.
6) Show layouts of wall, roof and liner panels on support framing, details of edge conditions, joints, panel profiles, corners, custom profiles, supports, anchorages, trim, flashings, closures, and special details to clearly indicate the proper assembly of building components. Distinguish between factory- and Site-assembled Work.
7) Insulations.
8) Vapor-retarders.
9) All required wall and roof penetrations.
10) Include details of ventilators, gutters and downspouts and similar auxiliary and accessory system components.
b. Contractor shall note Work not supplied by metal building systems manufacturer and who is to supply such Work.
2. Product Data:
a. Manufacturer's complete product information, specifications and installation instructions for metal building components and accessories. Include material descriptions, dimensions and profiles of individual system.
3. Samples:
a. 6.0-inch square sample of vapor retarders.

b. Sealant color samples.
c. Engineer's review will be for color and profile, only. Compliance with all other requirements is the responsibility of Contractor.

B. Delegated Design Submittals:
1. Design Data: Submit the following:
a. Design Calculations:
1) Complete calculations for the building framing, cold formed members, roofing and siding, as one package with the Shop Drawings. Structural calculations shall include all specified performance criteria, required load cases and load combinations used in the design and resulting member forces, reactions, deflections, story drift, and other anticipated movements in the metal building system. The magnitude of maximum column reactions on foundations from all critical load combinations shall be tabulated separately. Critical load combinations used in the final sizing of members shall be emphasized. All calculations and assumptions shall be presented so that Engineer can easily follow the progress and logic of Contractor's professional engineer. The design analysis shall include the name and office phone number of the designer to answer questions during the shop drawing review.
2) Design calculations shall be signed, sealed, and dated by Contractor's professional engineer. State of professional engineer's registration, registration number, and name on seal shall be clearly legible.

C. Informational Submittals: Submit the following:
1. Certificates.
a. Certification by professional engineer that metal building system design is in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice. This letter shall state the following:
1) Name and location of Project.
2) Order number.
3) Name of manufacturer.
4) Name of Contractor.
5) Building dimensions, including width, length, height, and roof slope.
6) Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7) Governing building code and year of edition.
8) Design Loads: Include dead load, roof live load, collateral loads, impact loads, roof snow load, deflection, wind loads/speeds and exposure, design spectral response accelerations at short and 1-second periods (SDS & SD1), seismic importance factor (I), response modification factor (R), seismic response coefficient (Cs), and auxiliary loads, such as loading superimposed on the system by erection equipment.
9) Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing authorities having jurisdiction.
10) Building-Use Category: Indicate category of building use and its effect on load importance factors.
2. Test and Evaluation Reports:

a. Material Test Reports: From a qualified testing laboratory indicating and interpreting material test results of structural steel bolts, structural steel, wall and roof panels, for compliance with requirements specified.
b. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing laboratory, indicating the following current products comply with requirements:
1) Insulation and Vapor-Retarders: Include reports for thermal resistance, fire test response characteristics, water vapor transmission, and water absorption.

3. Manufacturer's Instructions: Provide the following:
a. Indicate preparation requirements and assembly sequence.
b. Installation data.
c. Instructions for handling, start-up, and troubleshooting.
4. Qualification Statements: Submit qualifications for the following:
a. Manufacturer.
1) MBMA certificate verifying membership and accreditation per IAS AC472.
b. Professional Engineer.
c. Manufacturer's representative.
d. Installer.
e. Testing Laboratory.
f. Provide certification that all welders employed on the fabrication of the metal building systems have satisfactorily passed AWS qualification tests within the previous twelve months. Manufacturer shall ensure that all certifications are kept current.
5. Field Quality Control Submittals:
a. Report of field testing results.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Deliver components to the Site in manufacturer's original, unopened and undamaged packages, legibly labeled and accurately representing contents, indicating materials and components submitted on approved Shop Drawings. Clearly identify manufacturer, brand name, contents, color stock number, and order number on each package.
2. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete or masonry in ample time to prevent delaying the Work.
3. Inspect all products upon delivery to Site and notify Engineer in writing of loss or damage to products. Metal building system components that are damaged during delivery or while being handled shall not be stored on Site. Promptly remove, replace or remedy damage to new condition in accordance with manufacturer's instructions prior to installation. Do not erect components that become dented, scratched or damaged in any way. Damaged panels erected into the finished Work shall be removed immediately and replaced with new, undamaged material.
4. Do not open packages or remove markings until packages are inspected and accepted. Packages showing indications of damage that may affect condition of contents will not be acceptable. Packages with illegible or removed labels will be rejected for use in the Work.
5. Inspect materials, account for the presence of all hardware, auxiliary items and other accessories required for the Work, and reject components differing from approved Samples and Shop Drawings. Immediately remove rejected components from the Site.
6. Unload, store, and erect wall panels and other metal building system components in a manner that prevents bending, warping, twisting, and surface damage. Stack metal panels

horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

7. Comply with Section 01 6500, Product Delivery Requirements.

B. Storage and Protection:

1. Materials shall be stored out of contact with the ground. Materials other than framing and structural members shall be covered with weathertight coverings and kept dry.
2. Storage accommodations for roof and wall coverings shall provide good air circulation and protect from surface staining.
3. If crated system components become wet, remove all system components from the pallet crate immediately, separate and allow drying under protective cover meeting the requirements of this Specification.
4. Do not expose plastic insulation to sunlight, except to extent necessary for period of installation and concealment.
5. Protect plastic insulation against ignition at all times. Do not deliver plastic insulation materials to Site before it is required to be built into the Work.
6. Comply with 01 66 00, Product Storage and Handling Requirements.

1.7 PROJECT CONDITIONS

A. Environmental Conditions:

1. Weather Limitations: Proceed with erection only when weather conditions permit roof and wall panel installation to be performed according to manufacturer's written instructions and warranty requirements.

B. Site-Measurements:

1. Verify dimensions in areas of erection by taking measurements at the Site before fabrication. Indicate dimensions on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay.
2. Where Site-measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating components without Site-measurements. Coordinate supports, adjacent construction, equipment and locations of openings to ensure actual dimensions correspond to dimensions established for metal building system Work.

1.8 SCHEDULING

A. Schedule the arrival of metal building system components, auxiliary items and accessories to minimize the time they are stored at the Site before erection.

B. Do not proceed with the erection of metal building systems until Contractor can provide finished Work complying with all requirements of the Specifications.

C. Where metal building systems require the building-in of plates, inserts, anchors and other items, furnish required inserts to avoid delay in the Work of other trades. Provide setting drawings, templates, and directions for installation of plates, inserts and anchors, required by the Work of this Section but installed under other Sections.

D. Coordinate with other Work by furnishing Shop Drawings, inserts and similar items at the appropriate times for proper sequencing of construction without delays.

E. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.9 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties:
   1. Panel Coating Wear Warranty: Furnish a written warranty, signed by the manufacturer and running to benefit of Owner, agreeing to replace, for a period of 20 years from the date of Substantial Completion, wall, roof and auxiliary system components and accessories finish that shows excessive wear, as specified, and stating that the coil and spray coated polyvinylidene fluoride based coating specified complies with the following:
      a. Coating will not blister, peel, flake, check nor chip; and shall also be warranted against excessive color change, chalking and cracking, spalling, crazing, or from otherwise losing adhesion for a period of twenty years from the date of installation, to the extent that such shall create unsightly conditions, impair the intended architectural qualities of the building or otherwise fail to meet performance criteria specified, when viewed from a distance of 5 feet from the item.
      b. In the event that the coil coated polyvinylidene fluoride based coating fails to meet the specified standards the manufacturer shall, at his own expense, replace or field paint, at the discretion of Owner, all areas affected by the failure. In the event that repainting is selected, it shall be done at mutually agreeable intervals throughout the term of the warranty.
      c. The warranty does not apply where any failure is caused by accidents, or any external conditions or forces beyond the control of the manufacturer.
   2. Aluminum-zinc Coating Roof and Wall Panel Warranty: Furnish a written warranty, signed by the manufacturer and running to benefit of Owner, agreeing to replace, for a period of 25 years from the date of Substantial Completion, wall, roof and auxiliary system components and accessories finish that shows excessive wear, as specified.
   3. Material and Workmanship Warranty: Furnish a written warranty, signed by the manufacturer and running to benefit of Owner, agreeing to replace metal building system components that fail in material or workmanship within three years of the date of Substantial Completion. Failure of materials or workmanship shall include, but is not limited to, leakage or air infiltration, deflections, or deterioration of metal in excess of normal weathering, and in excess of performance criteria specified; and defects in, and improper arrangement of, the various parts, accessories, weatherstripping, and other components of the system.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System description, general:
   1. Metal building systems include complete, integrated sets of components and assemblies, capable of withstanding structural and other loadings, thermally induced movements, and exposure to weather in the area of the Site, without failure or infiltration of water into the

building interior. The system includes primary and secondary framing, roof and wall panels, auxiliary system components and all associated trim, complying with requirements shown and specified, all requirements of the metal building systems manufacturer, and governing authorities having jurisdiction at the Site.

2. Metal building systems also include all internal reinforcements and supports, fasteners, closure plates, flashing, fascias, and all other components necessary to complete the Work in a manner that provides a completely functioning system.
3. In some cases incidental accessories necessary to the proper functioning of the specified system or component may not be mentioned in the Specifications. Contractor shall follow the recommendations of the specified metal building system manufacturer and provide systems and components with all required incidental accessories and component items necessary for the proper functioning of the metal building or other building systems, at no additional expense to Owner. Provide materials matching the specified material and finish of similar items.
4. Provide specified material gages, or heavier gages, if calculations based on performance criteria indicate the need for heavier gage material. Where compliance with performance criteria indicates that materials of lesser gage, or size, may be adequate, provide specified gages and sizes as minimum acceptable standard.
5. Do not change material gages, system components or construction details after approval of Shop Drawing by Engineer.

B. Design Criteria:
   1. General:
      a. Provide metal building systems capable of withstanding controlling effects of gravity and lateral loads in accordance with basic load and load combinations in accordance with Laws and Regulations. Comply with applicable standards, recommendations and specified publications of MBMA, AISC, and ASCE 7, except to the extent more stringent requirements are specified or required by governing authorities having jurisdiction at the Site.
      b. Structural steel members and their connections shall be designed in accordance with AISC 360 for design requirements and allowable stresses.
      c. Structural cold-formed steel framing members and their connections shall be designed in accordance with AISI S100, for design requirements and allowable stresses.
   2. Dead Load:
      a. Dead load shall consist of the weight of the structural frame and all other materials of the metal building system.
   3. Live Loads:
      a. Roof live loads shall be determined and applied in accordance with the minimum applicable Building Code, but shall not be lower than a non-reducible minimum of 30 pounds per square foot.
   4. Roof Snow Loads:
      a. Loads induced by the weight of snow, including, but not limited to, balanced, unbalanced, drift, sliding loads, rain-on-snow loads, as determined in accordance with minimum applicable Building Code requirements and the Contract Drawings for the roof slope indicated.
   5. Rain Loads:
      a. Rain loads shall be computed and applied in accordance with the minimum applicable Building Code requirements and the Contract Drawings.
   6. Collateral loads:

a. Collateral load consisting of 5 pounds per square foot shall be applied to the entire structure to account for the weight of additional permanent materials other than the building system, including, but not limited to, sprinklers, mechanical systems, electrical systems, and ceilings. This allowance does not include the weight of hung equipment weighing 50 pounds or more. Any concentrated equipment loads larger than or equal to 50 pounds shall be investigated by the building manufacturer and the structure shall be strengthened as required. Contractor is responsible for providing the metal building system manufacturer the magnitude and location of all concentrated loads larger than or equal to 50 pounds.

7. Wind Loads:
   a. Wind loads on main lateral force resisting systems and components and cladding shall be computed and applied in accordance with the minimum applicable Building Code requirements and the Contract Drawings.
8. Coiling Door Frame Loads:
   a. Contractor shall obtain all superimposed loads resulting from overhead coiling doors from the manufacturer and provide all required information to the metal building system manufacturer in an expedite manner, to avoid metal building system design delays. Manufacturer's framing design shall consider all vertical and lateral loads imposed by the doors, including catenary forces.
9. Concentrated loads indicated on the Contract Drawings shall be applied at the locations shown.
10. Monorail beam support: Runway beam and runway beam supports for the monorail hoist shown and specified in Section 41 2200, Cranes and Hoists shall be designed as part of the building frame. Contractor shall provide all approved hoist loads to metal building manufacturer.
11. Seismic Performance: Provide metal building systems capable of withstanding the effects of seismic forces determined in accordance with the applicable Building Code using seismic design factors shown on the Drawings.
12. Foundation Design Requirements:
    a. Pinned connections shall be assumed at all column bases.
    b. The size of the building column base plates shall not exceed the pier and wall sizes indicated in the Contract Drawings and shall be configured to provide minimum anchor bolt edge distances indicated.

C. Performance Criteria:
1. General:
   a. The metal building system requirements shown are based on the specific system shown. Other manufacturer's systems with equal performance characteristics may be considered. Within these limitations Contractor shall be responsible for the structural adequacy, detailing and fabrication of the entire metal building system, including anchorage, and to make whatever modifications of, and additions to, the details as may be required to fulfill the performance requirements as acceptable to Engineer. Maintain the visual design concept as shown, including member sizes, profiles, support locations and alignment of components, as judged solely by Engineer. Clearly identify, in a manner that is highlighted to Engineer, all proposed substitutions, modifications, variations, unspecified features and "or equal" products. Provide complete comparative data, with specified products, at time of Shop Drawing submission.
2. Primary Frame Type:
   a. Rigid Clear Span: Solid member structural framing system without interior columns.
3. End Wall Framing:

a. For end walls not required to be expandable, provide manufacturer's standard primary frame, capable of supporting one half of a bay design load, and end wall wind columns.
b. For end walls designated to be expandable in the Contract Drawings, provide primary frame, capable of supporting full bay design loads, and end wall wind columns.

4. Secondary Frame Type:
   a. Contractor and pre-engineered building manufacturer shall design and provide additional secondary framing members as shown to resist the minimum loading shown on the Drawings.
      1) Carbon steel wide flange masonry wall lateral support perimeter girt.
         a) Maximum lateral load deflection: L/600
      2) Carbon steel Wide flange PC Plank support.
         a) Maximum live load deflection: L/360
5. Eave Height: As indicated in the Contract Drawings.
6. Bay Spacing: As indicated in the Contract Drawings.
7. Roof Slope: As indicated in the Contract Drawings.
8. Roof System: Manufacturer’s standard Vertical-rib, standing seam metal roof panels, with insulation.
9. Exterior Wall System: Manufacturer's standard site-assembled, insulated.
10. Provide vapor barrier conforming to ASTM E96/E96M.
11. Deflection Limits: Design component assemblies to withstand design loads with deflections no greater than the following:
    a. Roof elements not supporting ceilings: Vertical live load deflection of L/180 of the span.
    b. Roof elements supporting plastered ceilings: Vertical live load deflection of L/360 of the span.
    c. Roof elements supporting nonplaster ceilings: Vertical live load deflection of L/240 of the span.
    d. Steel framing above and along the sides of framed door openings shall be limited to L/360 of the opening width.
    e. Girts: Horizontal deflection of L/180 of the span.
    f. Framing providing lateral support for masonry cladding shall be L/600 of the framing span.
    g. Roof Panels: Vertical deflection of L/180 of the span. The design analysis shall establish that the roof, when deflected under applicable load combinations, will not result in a negative slope.
    h. Wall Panels: Horizontal deflection of L/180 of the span.
12. Drift limits:
    a. Lateral deflections, or drift, at the roof level in relation to the finished floor elevation shall be calculated based on a 50-year mean recurrence interval and shall not exceed H/400 or the working limits of the architectural and mechanical components.
    b. Design secondary framing system to accommodate deflection of primary structure, construction tolerances, and to maintain clearances at openings.
13. Thermal Movements: Provide metal roof and wall panel systems designed for thermal movements. Employ detailing and fabrication techniques that prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects resulting from the following maximum change (range) in ambient and surface temperatures.
14. Thermal Performance: Provide metal building roof and wall assemblies with the following thermal resistance values (R value):

a. Roof Assemblies: R-19+R-11.
b. Wall Assemblies: R-13+R-13.

15. Air Infiltration:
    a. Roof Panels: Provide roof panel assemblies with permanent resistance to air leakage through assembly of not more than 0.09 cfm/sq. ft. of fixed roof area when tested according to ASTM E1680 at a static air pressure difference of 4 pounds per square foot.
    b. Wall Panels: Provide wall panel assemblies with permanent resistance to air leakage through assembly of not more than 0.09 cfm/sq. ft. of fixed wall area when tested according to ASTM E283 at a static air pressure difference of 4 pounds per square foot.
16. Water Penetration:
    a. Roof Panels: Refer to specification Section 07 4113, Roof Panels.
17. Wind Uplift Resistance: Provide metal building systems capable of withstanding the effects of wind forces determined in accordance with the governing codes using wind design factors shown on the Contract Drawings. Provide roof panel assemblies that meet the requirements of UL 580 for the following wind uplift resistance:
    a. Class 90.

2.2 STRUCTURAL FRAMING MATERIALS

A. Hot-Rolled Structural Shapes: ASTM A36/A36M, A529/A529M, A572/A572M, or A992/A992M.

B. Hollow Structural Sections: ASTM A500/A500M, Grade B.

C. Steel Pipe: ASTM A53/A53M, Grade B.

D. Steel Plate, Bar or Strip: ASTM A36/A36M, A529/A529M, or A572/572M.

E. Structural Steel Sheet: Hot-rolled, ASTM A1011/1011M, or cold-rolled, ASTM A1008/A1008M.

F. Metallic-Coated Steel Sheet: ASTM A653/653M, structural steel quality, Grade 50, with G60 coating designation; mill-phosphatized.

G. Metallic-Coated Steel Sheet Pre-painted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M and the following requirements.
    1. Zinc Coated (Galvanized) Steel Sheet: ASTM A653/653M, G90 coating designation; structural steel quality.
    2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/792M, Class AZ50 coating, Grade 40; structural steel quality.

H. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A; carbon steel, hex-head bolts; carbon steel nuts; and flat, unhardened steel washers.
    1. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

I. High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy hex steel structural bolts, ASTM A563 heavy hex carbon steel nuts, and ASTM F436 hardened carbon steel washers.
    1. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

J. Anchor Bolts:
   1. Conform to the requirements of section 05 0533, Anchor Systems.

K. Primers: As selected by manufacturer for compatibility with finish paint systems specified in Section 09 9100, Painting, and capable of providing a sound substrate for Site-applied topcoats, despite prolonged exposure without topcoat protection.

2.3 INSULATION MATERIALS

A. Fire-Test-Response Characteristics for Insulation: Provide insulation with the fire-test-response characteristics indicated, as determined by testing identical products in compliance with test methods specified below by a testing and inspecting agency acceptable to governing authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface-Burning Characteristics: ASTM E84.
   2. Combustion Characteristics: Type I, ASTM E136.

B. Glass-Fiber-Blanket Insulation: Thermal insulation shall be flexible, resilient, odorless, incombustible; complying with ASTM C991, Type I, of 0.5-pound per cubic foot density, thickness as shown, with a flame-spread rating of 25 or less, and 2-inch wide, continuous, vapor-tight edge tabs.

C. Vapor-Retarder Facing: Complying with ASTM C1136, with permeance not greater than the following when tested according to ASTM E96, Desiccant Method.
   1. Composition: Polypropylene-faced, fiberglass-polyester-blend fabric backing, with permeance not greater than 0.02 perm.

D. Retainer Strips: 0.019-inch thick, formed, galvanized steel or polyvinlychloride retainer clips colored to match insulation facing.

E. Vapor-Retarder Tape: As recommended by the manufacturer.

2.4 FABRICATION, GENERAL

A. Shop-fabricate bearing plates, and other plates as required for building erection, to the required sizes, sections and profiles, complete with base plates welded in place, and with all required holes for anchoring or connections shop-drilled, or punched, to template dimensions.
   1. Shop Connections:
      a. Unless otherwise shown or indicated, shop connections may be welded or bolted connections. Welds shall be 3/16-inch minimum.
   2. Site Connections:
      a. Field connections, unless otherwise shown or indicated, shall be made with high-strength bolts, and shall be bearing-type connections.
      b. Use field welding only where shown or indicated or where approved by Engineer.

B. Fabricate components, and necessary field connections required for erection, to permit easy assembly and disassembly. Fabricate components such that once assembled they may be disassembled, repackaged and reassembled with a minimum amount of labor and maximum salvageability.

C. Clearly and legibly mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.

D. Fabricate framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Cold-formed members shall be free of cracks, tears, and ruptures.

E. Shop-Painting: Clean surfaces to be primed of loose mill scale, rust, dirt, oil, grease, and other matter that might interfere with paint bond. Follow procedures and substrate preparation recommendations of the painting manufacturers for the paint systems specified in Section 09 9100, Painting.

F. Factory-Priming for Site-Painted Finish: Apply the specified primer immediately after cleaning and pretreating.

2.5 STRUCTURAL FRAMING FABRICATION

A. Primary Framing:
   1. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind and seismic bracing.
      a. Shop-fabricate framing components to indicated size and section with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted Site-assembly.
      b. Provide frame span and spacing indicated. Slight variations in span and spacing may be acceptable, if necessary to meet manufacturer's standard, as approved by Engineer.
   2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural steel shapes.
   3. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural steel shapes. Provide interior columns fabricated from round steel pipe or tube, or shop-welded, built-up steel plates.
   4. Frame Configuration: Gable.
   5. Exterior Column Type: Tapered depth.
   6. Rafter Type: Tapered.
   7. Join flanges to webs of built-up members by a continuous submerged arc-welding process.
   8. Brace compression flange of primary framing by angles connected between frame web and purlin or girt web, so flange compressive strength is within allowable limits for any combination of loadings. Location of bracing shall be per the requirements of the building designer.
   9. Brace webs against buckling in beam-column connections of moment frames.
   10. Weld clips to frames for attaching secondary framing members.

B. Secondary Framing:
   1. Provide metal building system manufacturer's standard structural secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural steel sheet or roll-formed, metallic-coated steel sheet prepainted with coil coating, unless otherwise shown or specified.
   2. Purlins: C- or Z-shaped sections; fabricated from minimum 0.0598-inch thick steel sheet, built-up steel plates, or structural steel shapes; minimum 2-1/2-inch wide flanges.
      a. Depth: To meet system performance requirements.

~~3. Girts: C- or Z-shaped sections; fabricated from minimum 0.0598-inch thick steel sheet, built-up steel plates, or structural steel shapes. Form ends of Z-sections with stiffening lips angled 45 to 50 degrees to flange and with minimum 2-1/2-inch wide flanges.~~

~~a. Depth: To meet system performance requirements.~~

~~4.~~3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from minimum 0.0598-inch thick steel sheet, built-up steel plates, or structural steel shapes; to provide adequate backup for both roof and wall panels.

~~5.~~4. Flange and Sag Bracing: Minimum 1-5/8-inch by 1-5/8-inch structural steel angles, with a minimum thickness of 0.0598-inch, to stiffen primary frame flanges.

a. Lateral bracing shall be provided for both flanges. Flange bracing shall be located as indicated and as required by analysis, but no less than at quarter points of the member's span. Antiroll clips shall be provided at each support.

~~6.~~5. Base or Sill Angles: Minimum 3-inch by-2-inch by 0.0747-inch thick, zinc-coated (galvanized) steel sheet.

~~7.~~6. Purlin and Girt Clips: Minimum 0.0747-inch thick, zinc-coated (galvanized) steel sheet.

~~8.~~7. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from minimum 0.0747-inch thick, zinc-coated (galvanized) steel sheet.

~~9.~~8. Framing for Openings: Channel shapes; fabricated from minimum 0.0598-inch thick, cold-formed, structural steel sheet or structural steel shapes, as required by analysis. Frame head and jamb of door openings, and head, jamb, and sill of other openings.

~~10.~~9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

C. End-Wall Framing:

1. Provide metal building system manufacturer's standard primary end-wall framing fabricated for Site-bolted assembly.
2. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural steel sheet; with minimum thickness of 0.0747-inch.
3. End-Wall Rafters: C-shaped, cold-formed, structural steel sheet; with minimum thickness of 0.0598-inch.

D. Bracing: Provide bracing using any method specified below, at manufacturer's option, unless a specific type of bracing is noted on the Contract Drawings. Bracing shall be located as to not interfere with any exterior wall openings, such as duct locations, doors, and appurtenances.

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade D; or ASTM A529/A529M, Grade 50; 1/2 inch diameter steel; threaded full length or threaded a minimum of 12 inches at each end.
2. Cable: ASTM A475, 1/4 inch diameter, extra high strength grade, Class B zinc coated, seven strand steel; with threaded end anchors.
3. Rigid Portal Frames: Fabricate from shop welded, built up steel plates or structural steel shapes to match primary framing; of size required to withstand design loads.

E. Bolts: Provide stainless steel bolts, unless structural framing components are in direct contact with roof and wall panels. Provide galvanized bolts when structural framing components are in direct contact with roof and wall panels.

2.6 ROOF PANEL FABRICATION

A. Provide roof panels in accordance with Section 07 4113, Roof Panels.

2.7 FASCIA AND SOFFIT PANEL FABRICATION

A. Fascia Panels: Manufacturer's standard panels complying with the following:
   1. Match roof panel profile and material.

B. Soffit Panels: Manufacturer's standard panels complying with the following:
   1. Match wall panel profile and material.
   2. Flat Panels: Fabricate from 50-ksi steel sheets, factory-formed to provide flat panel with 16-inch coverage. Panel shall be 1-inch deep. Design side laps for mechanical attachment to structure by interlocking panel edges and securing panels with concealed fasteners. Factory-apply sealant at each interlocking joint. Comply with the following:
      a. Material: Aluminum-zinc alloy-coated steel.
      b. Metal Thickness: 24 gage.

C. Finish panel surfaces to match adjacent panels as follows:
   1. Fascia Panels: Color to be selected by Engineer.
   2. Soffit Panels: Color to be selected by Engineer.

2.8 DOOR AND FRAME FABRICATION

A. Doors: Provide doors in accordance with Section 08 1116, Aluminum Doors and Frames.

B. Finish Hardware: Provide finish hardware in accordance with Section 08 7100, Door Hardware.

2.9 LOUVER FABRICATION

A. Louvers: Refer to Section 08 9000, Louvers and Vents.

2.10 AUXILIARY SYSTEM COMPONENTS AND MISCELLANEOUS ACCESSORIES

A. Accessories shall be as specified in Section 8 of the Recommended Guide Specifications in the MBMA Manual, including gutters and downspouts.
   1. Provide sheet metal accessories of same material and in same finish as roof and wall panels, unless otherwise specified.

B. Gutters and Downspouts: Provide the following:
   1. Form from 26 gage, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil-coating. Match profile of roof fascia and rake trim
   2. Gutters: Formed in sections not less than 8 feet in length, complete with end pieces, outlet tubes, and all special pieces that may be required and sized according to SMACNA's "Architectural Sheet Metal Manual." Unless otherwise shown, provide expansion-type slip joint at the center of runs. Furnish gutter supports spaced at 36 inches on centers, constructed of same metal as gutters. Provide standard aluminum wire ball strainers at each outlet.
   3. Downspouts: Formed from 26 gage, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil-coating, in sections approximately 10 feet long, complete with elbows and offsets. Join sections with minimum 1-1/2 inches telescoping joints. Provide fasteners at top, bottom and at 5 foot centers designed to securely hold downspouts not less than 1 inch away from walls. Finish downspouts to match wall panels.

4. Provide preformed rubber weatherseals to completely fill roof corrugation voids prior to installation of contour gutter.
5. Provide 26-gage galvanized steel closures to close corrugations in wall panels prior to installation of gutters.

C. Contour Eave and Gable Trim: Provide the following:
1. Gable and eave trim shall be contour type fabricated from 26-gage galvanized steel, ASTM A653/A653M, G90 coating.
2. Gable and eave trim shall have a factory applied paint finish.
3. Install preformed corner closures to match the configuration of the gable and eave trim.
4. Install preformed rubber weatherseals to completely fill the roof panel corrugation voids prior to installation of eave trim.
5. Install preformed wall closures to completely fill the wall panel corrugation voids prior to installation of eave and gable trim. Wall closures shall be 26-gage galvanized steel factory painted in slate black.

D. Flashing and Trim:
1. Trim and wall panel transitions and other wall accessories for doors and windows and other openings through the metal panels shall be as required to coordinate with doors, window walls and other components specified in other Sections and Contracts.
2. Trim and wall panel transitions and other wall accessories for doors and windows and other openings through the metal panels shall be as required to coordinate with doors, window walls and other components specified in other Sections and Contracts.
3. Provide manufacturer's standard profiles to the extent possible. Custom fabricate profiles where required, or shown, and to accommodate the Work of other Sections and Contracts. Provide extruded aluminum trim with polyurethane thermal break for all window wall openings.
4. Form flashing and trim from 26 gage, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil-coating.
5. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent roof or wall panels.
6. Door Head and Jamb Opening Trim: Minimum 24 gage steel sheet. Trim head and jamb of door openings, and head, jamb, and sill of other openings.
7. Base Molding Trim: Provide continuous interior base moldings in all perimeter wall areas except toilet rooms, fabricated from 22-gage galvanized steel. Finish shall be slat black. Provide base molding 3-7/8-inches high by 3/4-inch wide with a sloping top.

E. Louver, Personnel and Overhead Door Openings: Provide framing for all openings, consisting of properly designed galvanized steel headers and posts, drip gutters and door post flashing and trim all coordinated with selected metal wall panel system for type and location. Provide size shown.

F. Fasteners:
1. Sheet Panel Fasteners: Manufacturer's standard system of self- tapping screws, bolts and nuts, self-locking rivets, self-locking bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.
2. Provide metal-backed neoprene washers under heads of fasteners bearing on weather side of panels.

3. Locate and space fastenings for true vertical and horizontal alignment. Use appropriate fastening tools to obtain controlled uniform compression, for positive seal without rupture of neoprene washer.
4. Provide fasteners with heads matching color of roofing or siding sheets by means of plastic caps or factory-applied coating. Provide self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Comply with the following:
5. Fasteners for Roof and Wall Panels: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of panels.
6. Fasteners for Flashing and Trim: Blind stainless steel rivets or stainless steel self-drilling screws with hex washer head.

2.11 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
   1. Comply with MBMA's "Low Rise Building Systems Manual," Chapter IV, Section 9, "Fabrication Tolerances."

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the areas and conditions under which the metal building systems are to be erected and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

A. Clean substrates of all substances, including grease, oil, rolling compounds, incompatible primers, and loose mill scale, that may impair bond of materials.

B. Clean and prepare items to be finished with field-applied coatings in compliance with Section 09900, Painting.

C. Survey the footings and foundations to assure conformance with approved shop drawings. Correct all deficiencies before beginning structural steel erection.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Place and secure metal building systems in accordance with approved Shop Drawings, and the Contract Documents.

B. Do not field cut, drill, or alter structural members without written approval from Engineer.

C. Set structural framing in locations and to elevations indicated and according to AISC specifications. Maintain structural stability of frame during erection.

D. Baseplates, Leveling Plates and Bearing Plates: Clean concrete bearing surfaces of bond-reducing materials and roughen surfaces before setting baseplates and bearing plates. Clean bottom surface of baseplates and bearing plates.
   1. Set baseplates and bearing plates for structural members on wedges, shims, or setting nuts.
   2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of baseplate or bearing plate before packing with grout.
   3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
      a. Comply with manufacturer's written instructions for proprietary grout materials.

E. Align and adjust framing members before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Make adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Splice members only where shown or specified.
   3. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.

F. Secondary Framing: Erect framing true to line, level, plumb, rigid, and secure. Fasten secondary framing to primary framing using clips with field connections using non-high-strength bolts. Hold rigidly to a straight line by sag rods.
   1. Provide rake or gable purlins with tight-fitting closure channels and fascia.
   2. Locate and space wall girts coordinated with door and window arrangements and heights.
   3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

G. Bracing: Install bracing in roof and sidewalls where shown and as required by design. Tighten rod and cable bracing, if used, to avoid sag.

3.4 FASCIA AND SOFFIT PANEL INSTALLATION

A. General: Provide panels full width of fascia and soffits. Install panels perpendicular to support framing.
   1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Install panels with vertical edges plumb. Lap ribbed or fluted panels one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
   2. Site-cutting of fascia and soffit panels with a torch is not permitted.
   3. Fasten flashing and trim around openings and similar elements with self-tapping screws.
   4. Install screw fasteners with power tools having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
   5. Use stainless steel fasteners for exterior applications and galvanized fasteners for interior applications.
   6. Locate and space fastenings in true vertical and horizontal alignment.

B. Fascia Panels: Align bottom of panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal panels with weather closures where fascia meet soffits, along lower panel edges, and at perimeter of all openings.

C. Soffit Panels: Flash and seal panels with weather closures where soffit meets walls and at perimeter of all openings.

3.5 INSULATION INSTALLATION

A. General: Install insulation concurrently with panel installation, according to manufacturer's written instructions and as follows:
   1. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.
   2. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.
   3. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
   4. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.
   5. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
   6. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

3.6 DOOR, HARDWARE, AND LOUVER INSTALLATION

A. General: Comply with manufacturer's written instructions for installing components. Coordinate installation with wall flashings and other building system components.

B. Doors and Frames: Refer to Section, 08 1613, Fiberglass Reinforced Plastic Doors and Frames.

C. Overhead Doors: Refer to Section, 08 3323, Overhead Coiling Doors.

D. Windows: Install windows in accordance with manufacturer’s written instructions and approved shop drawings. Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels:

E. Finish Hardware: Install hardware in accordance with manufacturer’s written instructions and approved shop drawings. Mount units at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.”

F. Louvers: Refer to Section 08 9000, Louvers and Vents.

3.7 AUXILIARY SYSTEM COMPONENTS AND ACCESSORY INSTALLATION

A. General: Install gutters, downspouts, ventilators, and other accessories according to manufacturer's written instructions and approved shop drawings, with positive anchorage to building and weathertight mounting. Coordinate installation with flashings and other components.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
   3. Pipe Flashing: Form flashing around pipe penetration and roof panels. Fasten and seal to roof panel as recommended by manufacturer.
   4. Dissimilar Materials: Separate metal from incompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet on centers using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches on centers in between.
   1. Tie downspouts to underground drainage system indicated.

3.8 FIELD QUALITY CONTROL

A. Site Tests and Inspections: Materials and erection procedures shall be subject to inspection and tests at the Site conducted by qualified testing laboratory. Such inspections and tests do not relieve Contractor of responsibility for providing the Work in accordance with the Contract Documents.
   1. Contractor shall employ testing laboratory to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
      a. Testing laboratory shall conduct and interpret tests, prepare and state in each report of results whether test specimens comply with the Contract Documents and specifically state all deviations.
      b. High-strength Bolted Connections: All high-strength bolted connections shall be visually inspected. Inspection shall determine whether the Work conforms to Sections 2, 3, and 8 of AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
         1) For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning.
         2) For connections that are not slip critical and not subject to direct tension, bolt does not need to be inspected for bolt tension, but shall be visually inspected to verify that plies of connected elements are in snug contact.
         3) Where bolts or connections are defective, correct defective workmanship, remove and replace, or correct as required all defective bolts and connections.

Contractor shall pay for correcting defective Work and tests required to confirm integrity of corrected Work.

c. Welds: All welds shall be visually inspected.
   1) Where visually defective welds are evident, further test welds using non-destructive methods. If welds are determined to be acceptable, Owner shall pay for non-destructive testing. When welds are defective, Contractor shall pay for non-destructive testing.
   2) Correct, or remove and replace, defective Work as directed by Engineer.
   3) Contractor shall pay for corrections and subsequent tests required to determine weld conformance with the Contract Documents.

B. Manufacturer's Services:
   1. Provide at the Site services of qualified manufacturer's representative, who is familiar with the design of the building supplied and experienced in the erection of metal buildings, from the start of the structural framing erection until completion of the installation of exterior covering, to ensure that the building meets the specified requirements.

3.9 ADJUSTING, CLEANING AND PROTECTION

A. Protection of Aluminum from Dissimilar Materials:
   1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 9100, Painting.

B. Touchup Painting: Immediately after erection, clean, prepare, and prime or reprime welds, bolted connections, and abraded surfaces of prime-painted primary and secondary framing, accessories, and bearing plates, as specified in Section 09 9100, Painting.

END OF SECTION 13 3419

SECTION 21 1010

FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fire protection riser piping from building entrances to distribution systems, including alarm valves, flow switches, and alarm horns.
2. Fire protection distribution piping from risers to sprinkler heads, including access to valves in enclosed ceilings and walls.
3. Contractor shall determine volume and pressure of incoming water supply from water flow test data and then design each system to NFPA 13 occupancy requirements as indicated.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
1. Water Supply: Water supply availability is indicated on Drawings and by requirements of this section. The owner shall provide the following information:
a. Static Pressure in psig.
b. Residual Pressure in psig at gpm flow.
c. Source: Hydrant No. indicated on Drawing.
d. Date of Test.
e. "Test Conducted by" information.
2. System No. 1 – Membrane Bldg. - Chemical Rooms:
a. Occupancy Classification: Ordinary Hazard, Group 2
b. System Type: Wet Pipe.
c. Area of Sprinkler Operation: 1500 sq ft.
d. Density of Water Application: 0.2 gpm/sq ft.
e. Maximum Area of Sprinkler Coverage: As required by NFPA 13
f. Allowance for Outside Hose: 250 gpm.
3. System No. 2 – Membrane Bldg. - Basement:
a. Occupancy Classification: Ordinary Hazard, Group 1
b. System Type: Wet Pipe.
c. Area of Sprinkler Operation: 1500 sq ft.
d. Density of Water Application: 0.15 gpm/sq ft.
e. Maximum Area of Sprinkler Coverage: As required by NFPA 13
f. Allowance for Outside Hose: 250 gpm.
4. System No. 3 – Chemical Feed Bldg. – Polyortho Room:
a. Occupancy Classification: Ordinary Hazard, Group 2
b. System Type: Wet Pipe.
c. Area of Sprinkler Operation: 1500 sq ft.
d. Density of Water Application: 0.2 gpm/sq ft.
e. Maximum Area of Sprinkler Coverage: As required by NFPA 13
f. Allowance for Outside Hose: 250 gpm.
5. System No. 4 – Chemical Feed Bldg. – Fluoride Room (existing):
a. Occupancy Classification: Ordinary Hazard, Group 2
b. System Type: Wet Pipe.

c. Area of Sprinkler Operation: 1500 sq ft.
d. Density of Water Application: 0.2 gpm/sq ft.
e. Maximum Area of Sprinkler Coverage: As required by NFPA 13
f. Allowance for Outside Hose: 250 gpm.

1.3 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

Unit Type	Submittal Information Item
Piping	1, 2
Hangers, Supports and Anchors	1, 2
Valves	1
Switches, Horn, Meters and Gauges	1

B. Submittal Information.
1. Product Data: Submit manufacturer's data for fire protection systems, materials, and products.
2. Shop Drawings: Submit in accordance with Division 15 mechanical co-ordination section.
3. Approved Installation Drawings: Complete installation drawings showing piping sizes, sprinkler head locations and hydraulic flow calculations. Drawings shall be approved and signed by Local Fire Authority having Jurisdiction.
4. Qualifications:
   a. Provide copy of Automatic Sprinkler Contractor's State of Ohio License.
   b. Provide copy of Fire Protection Designer's State of Ohio Designer License.

C. Certificate of Installation: Submit certificate upon completion of fire protection piping work which indicates work has been tested in accordance with NFPA Nos. 13, 14, and 20, and that system is operational, complete, and has no defects.

D. Submit in accordance with Section 01 3300.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of fire protection piping systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Installer: A firm with at least 3 yrs of successful installation experience on projects with fire protection piping systems work similar to that required for Project.

C. Regulatory Requirements:
1. National Fire Protection Association (NFPA): Comply with NFPA Nos. 13, 14, and 20.
2. Factory Mutual (FM) Compliance: Comply with FM "Approval Guide."
3. Factory Mutual (FM) Labels: Provide sprinkler products bearing FM approval labels.
4. Underwriter's Laboratories (UL) Labels: Provide fire sprinkler piping products which have been approved and labeled by Underwriters Laboratories.
5. Local Fire Department/Marshall Regulations: Comply with governing regulations pertaining to fire sprinkler piping.

6. Insurance Compliance: Comply with regulations and requirements of OWNER'S insurance carrier. Where discrepancies exist between requirements of insurance carrier and local Fire Marshall, most stringent requirement governs.

1.5 FIRE PROTECTION PERMIT

A. Fire Protection installer shall be a licensed Automatic Sprinkler contractor in the state of Ohio.

B. Fire Protection installer to receive the Fire Suppression System permit from the Warren County Building Regulations Division and pay associated fees.
   1. Expected fees are as follows:
      a. $150 to register with the County
      b. $35 for the permit

C. Fire Protection installer to receive separate permit as required by the State Fire Marshal office and pay associated fees.

1.6 MAINTENANCE

A. Extra Materials:
   1. For each style and temperature range required, furnish additional sprinkler heads, amounting to 1 unit for every 100 installed units, but not less than 5 units of each.
   2. Furnish replacement heads with tools necessary for removal and replacement of heads in red colored, lockable carrying case.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION PIPING MATERIALS AND PRODUCTS

A. Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities indicated.

B. Where not indicated, provide proper selection determined by CONTRACTOR to comply with installation requirements.

C. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire protection piping systems.

D. Where more than 1 type of materials or products are indicated, selection is CONTRACTOR'S option.

2.2 BASIC IDENTIFICATION

A. Comply with Section 22 05 53 and following.
   1. Fire Protection Piping: Plastic pipe markers.
   2. Fire Protection Valves: Plastic valve tags.

2.3 BASIC PIPE, TUBE AND FITTINGS

A. Comply with Section 22 00 10 and following.

B. Non-Corrosive Areas:

1. Interior Piping:
    a. Black Steel Pipe:
        1) Pipe Weight: Schedule 10 for 5 in. and smaller; 0.134 in. wall thickness for 6 in. and 0.188 in., wall thickness for 8 in. and 10 in.
        2) Fittings: Mechanical grooved pipe couplings and fittings; roll groove or mechanical locking type.
    b. Copper Tube:
        1) Wall Thickness: Type M, hard drawn temper.
        2) Fittings: Wrought copper, solder joints.

C. Chemical Rooms:
1. Corrosive areas to be schedule 10, 316 stainless steel pipe with press joint fittings.
2. Press Joint Fittings: 316 stainless steel by Victaulic or Grinnel.
3. Grooved mechanical couplings shall consist of two ASTM A536 ductile iron housings, pressure-responsive, synthetic rubber gasket, and plated steel bolts and nuts.
    a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13.
        1) 1-1/4-inch through 8-inch: “Installation Ready” stab-on-design, for direct “stab” installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock EZ Style 009H (1-1/4 inch to 4 inch) and Victaulic Style 107H QuickVic (2 inch to 8 inch).
        2) 10-inch and larger: Victaulic Style 07 Zero-Flex® standard rigid coupling.
    b. Flexible Type: Use in seismic areas where required by NFPA 13.
        1) 2 inch through 8 inch: “Installation Ready” stab-on design, for direct “stab” installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic.
        2) 10 inch and larger: Victaulic Style 75 or 77 standard flexible couplings.

2.4 PIPING SPECIALTIES

A. Comply with Section 22 00 10 and provide following.
1. Pipe escutcheons.
2. Dielectric unions.
3. Sleeves.
4. Sleeve seals.

2.5 BASIC HANGERS, SUPPORTS AND ANCHORS

A. Comply with Section 22 00 10 and following.
1. Adjustable steel clevises, adjustable steel band hangers, and adjustable band hangers for horizontal piping hangers and supports.
2. Two bolt riser clamps for vertical piping supports.
3. Steel turnbuckles and malleable iron sockets for hanger rod attachments.
4. Concrete inserts, top beam C clamps, side beam or channel clamps, and center beam clamps for building attachments.
5. Copper flashings for piping penetrations.
6. Pipe hangers located within corrosive areas (chemical rooms) shall be constructed of 316 stainless steel matching piping material.

2.6 BASIC VALVES

A. Comply with Section 22 00 10 and following.
   1. Interior Valves:
      a. Sectional: Rising stem gate valves.
      b. Check: Swing check valves.

2.7 SPECIAL VALVES

A. Fire Department Connections:
   1. Type: Storz flush mounted wall type with brass finish, threaded dust cap and chain of matching material and finish. Size to match Local Fire Department.
   2. Label: "Sprinkler - Fire Department Connection".
   3. Drain: 3/4 inch automatic drip, outside.

B. Double-Check Backflow Preventer
   1. Manufacturers:
      a. Watts Regulator Company.
      b. FEBCO, Division of CMB Industries.
      c. Hersey Products, Inc., A Grinnell Company.
      d. Conbraco Industries, Inc.
      e. Or equal.
   2. Double check backflow preventer: Factory-assembled and tested assemblies including inlet and outlet shutoff gate valves w/ OS&Y, inlet strainer, test cocks, and 2 positive check valves. Pressure Class: 175 psig.
      a. 2-1/2 in. Through 10 in.: Watts No. 709, or equal.
      b. Chain and locks to secure indicating valves in Open position.

2.8 BASIC METERS AND GAUGES

A. Comply with Section 22 00 10 and following.
   1. Pressure Gauges: 0 to 250 psi range.

2.9 FIRE PROTECTION SPECIALTIES

A. Manufacturers:
   1. Allen (W.D.) Manufacturing Division, J.W. Moon, Inc.
   2. Automatic Sprinkler Corporation of America.
   3. Chemetron Corporation.
   4. Elkhart Brass Manufacturing Company.
   5. Grinnell Fire Protection Systems Company, Inc.
   6. Viking Corporation.
   7. Western Fire Equipment Company.
   8. Or equal.

B. UL listed and in accordance with following list. Provide sizes and types which mate and match piping and equipment connections.
   1. Water Flow Indicators: Vane type water flow detectors.
   2. Exterior Alarm Horn: UL listed, weatherproof, red enameled finish120 Volt.
   3. Supervisory Switches: As recommended by manufacturer for use in service indicated.
   4. Automatic Sprinklers: Type indicated on Drawings, and in accordance with following list. Provide fusible links for 165° F (74° C) unless otherwise indicated.
      a. Upright.

b. Pendent.
c. Vertical sidewall.
d. Conventional; 40% discharge upward, 60% downward.
e. Flush pendent.
f. Concealed pendent.
g. Horizontal sidewall.
1) Finish: Chrome plate for occupied areas; cast brass for unoccupied areas.

5. Provide stainless steel construction materials in corrosive areas.
6. Sprinkler Cabinet and Wrench: Steel, baked red enameled sprinkler box with capacity to store ten sprinklers and wrench sized to sprinklers.

PART 3 - EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

A. Install mechanical identification in accordance with Section 22 05 53.

B. Install fire protection signs on piping in accordance with NFPA Nos. 13, 14, and 20 requirements and in accordance with requirements of authority having jurisdiction and OWNER'S insurance carrier. Where conflicting requirements exist, install in accordance with most stringent requirements.

3.2 INSTALLATION OF PIPE, TUBE, AND FITTINGS

A. Install in accordance with Section 22 00 10. Do not weld sprinkler distribution piping. Join by means of flanged or mechanical grooved type joints. Headers, risers, feed mains, cross mains may be shop welded in accordance with ASME B31.1 by welders certified under Section IX, ASME Code.

B. Fire Sprinkler Piping Systems:
1. Comply with requirements of NFPA No. 13 for installation of fire sprinkler piping materials. Install fire sprinkler piping products where indicated in accordance with manufacturer's written instructions, and in accordance with recognized industry practices, to ensure fire sprinkler piping complies with requirements and serves intended purposes.
2. Coordinate with other work, including plumbing piping, as necessary to interface components of fire sprinkler piping properly with other work.
3. Install sectional valves in inlet piping at bottom of each riser and in loops as indicated.
4. Mount supervisory switches on each sectional valve.
5. Install valved hose connections of sizes indicated or 3/4 in. size if not otherwise indicated, on sprinkler at ends of branch lines and cross mains at locations where indicated.
6. Install air vents at high points of sprinkler piping.
7. Install drain piping at low points of fire sprinkler piping. Extend main drains to hub drains. Extend local drains to safe location where water drained will not damage property, injure personnel or create nuisance.
8. Install manual shutoff at each audible alarm station.
9. Label sprinkler piping, valves, and specialties.

3.3 INSTALLATION OF AUTOMATIC SPRINKLERS

A. Provide necessary swing fittings in drop pipes to permit final adjustment of sprinkler location when ceiling tiles are being installed.

B. Layout piping system and center sprinkler in ceiling tiles of gridded ceiling system.

3.4 INSTALLATION OF PIPING SPECIALTIES

A. Install in accordance with Section 22 00 10.

3.5 INSTALLATION OF SUPPORTS, ANCHORS AND SEALS

A. Install in accordance with Section 22 00 10.

3.6 INSTALLATION OF VALVES

A. Install in accordance with Section 22 00 10.

3.7 INSTALLATION OF METERS AND GAUGES

A. Install in accordance with Section 22 00 10.

3.8 INSTALLATION OF FIRE PROTECTION SPECIALTIES

A. Install as indicated, and in accordance with NFPA Nos. 13 and 14.

3.9 CLEANING

A. Sprinkler Piping Flushing: Prior to connecting sprinkler risers for flushing, flush water feed mains, lead in connections and control portions of sprinkler piping. After fire sprinkler piping installation complete and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in NFPA No. 13. Continue flushing until water is clear and check to ensure debris has not clogged sprinklers.

3.10 FIELD QUALITY CONTROL

A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for 2 hrs, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
   1. Repair or replace piping system required to eliminate leakage in accordance with NFPA standards for “no visible leakage,” and retest as specified to demonstrate compliance.
   2. Notify ENGINEER and OWNER’S insurance carrier and Wisconsin code authority 48 hrs in advance of time and date of tests.

END OF SECTION 21 1010

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SECTION 22 0010

PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Domestic Water Piping Systems:
a. Domestic cold water piping.
b. Domestic hot water piping.
2. Waste and Vent Piping Systems:
a. Above ground, soil, waste, and vent piping within buildings including soil stacks, vent stacks, horizontal branches, traps, and connections to fixtures and drains.
b. Underground building drain piping including mains, branches, traps, connections to fixtures and drains, and connections to stacks terminating at connection to sanitary sewers 5 ft. outside inner face of foundation wall.
3. Drainage piping products.
4. Valves and accessories.
5. Fixtures and trim.
6. Plumbing equipment.
7. Insulation.
8. Pipe specialties.

1.2 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

	Unit Type	Submittal Information Item
1.	Valves	1
2.	Hose Bibbs and Wall Hydrants	1
3.	Combination Shower/ Eyewash Units	1
4.	Drainage and Vent Products	1
5	Backflow Preventer	1
6.	Sump Pumps	1, 2, 3
7.	Electric Water Heater	1, 2, 3
8.	Fixtures and Trim	1, 2
9.	Insulation	1
10.	Domestic Hot Water Recirculating Pumps	1, 2, 3
11.	Pipe Specialties	1

B. Submittal Information:
1. Product Data: Manufacturer's specifications for units showing dimensions, weights, capacities, ratings, performance characteristics, gauges, color, and finished of materials, and installation instructions.
2. Shop Drawings, Assembly Drawings: Show unit dimensions, rough-in elevations, construction details, and field connection details.

3. Shop Drawings, Wiring Diagrams: Manufacturer's electrical requirements for power supply wiring to units.

C. Submit items in accordance with Section 01 3300.

D. Information submitted by CONTRACTOR, but not designated to be submitted will be returned without action by ENGINEER.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of plumbing systems products of types, materials, and sizes required, whose products have been in satisfactory use in similar service.

B. Plumbing Code Compliance: Comply with applicable portions of building codes pertaining to plumbing materials, construction, and installation of products.
1. Ohio Plumbing Code (2017).

C. PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste piping systems.

1.4 PLUMBING PERMIT

A. Plumber must be a licensed plumber in the state of Ohio

B. Plumber to receive the plumbing permit from Warren County and pay associated fees.
1. Expected fees are as follows:
a. $55 for the permit (up to 10 fixtures)
b. Additional $5 per plumbing fixture
c. $45 for water service connection
d. $45 for sewer service connection
e. $10 for back-flow preventer (each)

PART 2 - PRODUCTS

2.1 GENERAL

A. Where more than one type is indicated, selection is CONTRACTOR'S option or compliance with governing regulations.

B. Size system drain piping as shown or, if not shown, as required to properly drain piping systems, including valves and equipment.

C. Manufacturer's equipment used as basis of design for project is name indicated in Specifications for particular type of equipment or application contained in these Contract Documents. If no manufacturer listed, basis of design is industry standard indicated.

D. All newly installed or replacement pipes, pipe fittings, plumbing fittings, fixtures, faucets, backflow preventers and valves that are installed on potable water systems or systems that are designed to distribute water for potable water use, are required to meet the new Reduction of Lead in Drinking Water Act, which establishes a maximum lead content of 0.25 percent by weighted average of wetted surfaces.

2.2 WATER SUPPLY SYSTEM

A. Tube Size 2-1/2 in. and smaller, interior non-chemical room areas:
   1. Copper Tube: ASTM B88, Type L.
   2. Fittings: Wrought copper solder joint.
   3. Valves: Class 125 bronze ball valve.

B. Tube Size 2-1/2 in. and smaller, interior chemical rooms:
   1. Chlorinated Polyvinyl Chloride Tube, (CPVC): Schedule 80, ASTM 2846.
   2. Fittings: CPVC Schedule 40 socket type.
   3. Valves: CPVC ball valve.
   4. CPVC plastic pipe must meet Plumbing Code for potable drinking water.
   5. Solvent weld joints must include a primer of contrasting color to the pipe and cement, or a one-step solvent cement complying with ASTM F493 and ASTM D2826.

2.3 WASTE, VENT AND STORM SYSTEMS PIPING

A. Pipe Sizes 6 in. and smaller, above grade:
   1. Poly Vinyl Chloride (PVC) plastic pipe.
   2. Pipe Weight: Type DWV, ASTM D2665, D2949 or F891.
   3. Fittings: PVC plastic, Type DWV, socket type, solvent cement joints.

B. Pipe Size 6 in. and smaller, below grade:
   1. Poly Vinyl Chloride (PVC) plastic pipe.
   2. Pipe Weight: AWWA C900, Class 150, DR-18.
   3. Fittings: Ductile iron or cast iron in accordance with AWWA C110/A21.10.
   4. Joints: Push-on with integral bell and slip-type elastomeric gasket.

2.4 SUMP PUMP PIPING

A. Pipe Size 1-1/4 in.:
   1. Steel Pipe: ASTM A53/A53M, galvanized, Schedule 40.
   2. Fittings: Class 125 galvanized cast iron threaded drainage.

2.5 DRAINAGE PIPING PRODUCTS

A. Floor Cleanout (FCO):
   1. Manufacturers:
      a. Zurn Model Z1400 “Level-Trol”.
      b. J.R. Smith.
      c. Or equal.
   2. Cast iron body, round adjustable, scoriated secured nickel bronze top, straight thread gasket seal closure plug.

B. Wall Cleanouts (WCO):
   1. Manufacturers:
      a. J.R. Smith, Figure 4422C.
      b. Zurn.
      c. Or equal.
   2. Cast bronze body adaptable to pipe with taper thread countersunk plug and shallow cover.

C. Flashing Flanges:
   1. Products recommended by manufacturer for use in service indicated.
   2. Include clamping device.

D. Floor Drain (FD-1):
   1. Manufacturers:
      a. Zurn Model Z415B.
      b. J.R. Smith.
      c. Or equal.
   2. Vandal proof cast iron floor drain, in sizes indicated, with combination invertible membrane clamp, 8 in. polished bronze strainer and adjustable collar with seepage slots.
   3. Screw anchors matching strainer finish.

E. Floor Drain (FD-2):
   1. Manufacturers:
      a. Zurn Model Z415E.
      b. J.R. Smith.
      c. Or equal.
   2. Vandal proof cast iron floor drain, in sizes indicated, with combination invertible membrane clamp, 8 in. polished bronze strainer, adjustable collar with seepage slots and 4" diameter funnel.
   3. Screw anchors matching strainer finish.

F. Floor Drain (FD-3):
   1. Manufacturers:
      a. Zurn, Figure ZM1752.
      b. J.R. Smith.
      c. Or equal.
   2. 12-in. by 12-in. Sani-flor receptor, 10-in. deep, 16 gage 316 stainless steel, bottom outlet, inside caulk, in sizes indicated, 3/4 grate, anti-splash stainless steel interior dome strainer.

G. Trench Drain (TD-1):
   1. Manufacturers:
      a. Zurn Model Z890-DGE.
      b. ACO
      c. Or equal.
   2. Modular channels are 60" long, 7-inch wide reveal with 4-inch throat, #16 ga. stainless steel modular channel conforming to ASTM A-240, type 304. Channels have bolted, flanged connection between channel sections and will stay connected during installation. Channels have smooth, 1-1/2-in. radiused self-cleaning bottom with a Manning's coefficient of 0.009 and 1.04% or neutral 0% built in slope.
   3. Provide No-hub bottom outlet or end outlet connection as shown on drawings.
   4. Provide closed end caps.
   5. Provide gasket between flanged connections.
   6. Provide ductile iron slotted grates, Zurn P6-DG, 20-in. x 5-3/8-in., conforming to DIN rating Class E, ANSI rating of Special-Duty, H-20 load rated, FAA load rated and ASTM A536 Grade 80-55-06. Grates shall lock down to frame.
   7. Provide trench drain lengths and invert depths as indicated on drawings.

H. Trench Drain (TD-2):
   1. Manufacturers:

a. Zurn Model Z706-HDS-DGE-USA.
b. ACO
c. Or equal.

2. Provide frame and grate system to be used with cast-in-place concrete trench, sloped at a min. 1/16-in per ft. See Structural drawings for trench drain details.
3. Frame and grate system shall be 120 in. long, 6-in wide and have a clear opening. Frame shall mechanically lock into the concrete surround every 10-in.
4. Frame: Heavy-duty stainless-steel frame assembly, 0.105 in. thick, conforms to ASTM A-240, Type 304, with twelve 4-in long concrete anchors per 120 in. length of trench.
5. Grate: Provide ductile iron slotted grate, Zurn DGE-USA, supplied in 20-in nominal lengths with 5/16 in wide slots and ¾-in bearing depth, conforming to DIN rating Class E, ANSI rating of Special-Duty, H-20 load rated, FAA load rated and ASTM A536 Grade 80-55-06.
6. Grate lockdown bars shall be integral to frame.
7. All welds must be performed by certified welder per ASTM standard AWS D1.6.
8. Provide No-hub bottom outlet or end outlet connection as shown on drawings.
9. Provide trench drain lengths and invert depths as indicated on drawings.

2.6 BALL VALVES

A. Ball Valves 3/4 in. and smaller:
1. Manufacturers:
a. Nibco, Figure T-585-Y.
b. Wolverine Brass.
c. Or equal.
2. Bronze body, screwed, brass or stainless-steel ball, full port, Teflon seat rings, 125 psi WP steam.

B. Ball Valves 1 in. through 2 in.
1. Manufacturers:
a. Nibco, Figure T-580-Y.
b. Wolverine Brass.
c. Or equal.
2. Bronze body, screwed, brass or stainless-steel ball, conventional port, Teflon seat rings.
3. 125 psi WP steam.

C. Ball Valves 1 in. through 2 in. (Chemical Rooms).
1. Manufacturers:
a. Nibco, Chemtrol CPVC Tru-Bloc, Tru-Union, Model D.
b. Spears.
c. Or equal.
2. CPVC body, includes socket and threaded end connections, CPVC ball, full port, O-ring beneath the PTFE seat.
3. 125 psi WP steam.

2.7 GATE VALVES

A. All gate valves shall have resilient seats rather than brass seats. Operating rods shall have O-Ring water seals rather than packing glands.

B. Manufacturers:
1. Stockham Valves and Fittings.

2. NIBCO, Inc.
3. Milwaukee Valve Company, Inc.
4. Or equal.

C. 2 in. and Smaller: ASTM B62 Class 125, bronze, screw-in bonnet, rising stem, ASTM B62 solid bronze wedge.
1. Threaded Ends: Stockham Figure B-100, or equal.
2. Solder Ends: Stockham Figure B-109, or equal.

D. MSS Compliance:
1. Cast Iron Valves: MSS SP-70.
2. Bronze Valves: MSS SP-80.

E. ANSI Compliance:
1. Dimensions: ANSI B16.10.

2.8 DRAIN VALVES:

A. Manufacturers:
1. Conbraco Industries, Inc.
2. NIBCO, Inc.
3. Woodford Manufacturing Company.
4. Or equal.

B. Drain Valves: Provide 3/4 in. drain valves where indicated.
1. Threaded Ends: Conbraco 31 Series, or equal.

C. ASSE Compliance: ASSE 1005.

2.9 HOSE BIBBS (HB):

A. Manufacturers:
1. Woodford Manufacturing Company.
2. +Wilkins Regulator, Division of Zurn Industries, Inc.
3. Wolverine Brass, Citation-Walther Corporation.
4. Or equal.

B. Indoor Application: ASTM B62 brass construction, renewable composition disc, wheel handle, 3/4 in. inlet, 3/4 in. hose outlet, with integral vacuum breaker-backflow preventer.
1. Threaded Ends: Woodford Model 24P, or equal.
2. Solder Ends: Woodford Model 24C, or equal.

C. ASSE Compliance: ASSE 1011.

2.10 WALL HYDRANTS (WH):

A. Manufacturers:
1. Woodford Manufacturing Company.
2. Wilkins Regulator, Division of Zurn Industries, Inc.
3. Or equal.

B. Projecting Non-freeze Wall Hydrants: Cast ASTM B62 brass wall hydrant, powder-coated, die cast aluminum handle, Adjustable polycarbonate wall flange automatic draining with 1-piece valve plunger, stainless steel seat, integral vacuum breaker, 3/4 in. inlet, 3/4 in. hose outlet. Provide length suitable for wall thickness. Provide wall faucet mounting sleeve, Woodford Model WF-MS.
   1. Threaded Ends: Woodford Model 17CP3, or equal.
   2. Solder Ends: Woodford Model 17C, or equal.
   3. ASSE Compliance: ASSE 1011.

2.11 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTERS

A. Manufacturers:
   1. Watts Regulator Company.
   2. FEBCO, Division of CMB Industries.
   3. Hersey Products, Inc., A Grinnell Company.
   4. Conbraco Industries, Inc.
   5. Or equal.

B. Reduced Pressure Principle Backflow Preventors: Factory-assembled and tested assemblies including inlet and outlet shutoff valves, inlet strainer, test cocks, and pressure differential relief valve located between 2 positive check valves. Pressure Class: 175 psig.
   1. 3/4 in. Through 10 in.: Watts No. 909, or equal.

C. ASSE Compliance: ASSE 1013.

2.12 ACCESSORIES

A. Bellows Air Cushions:
   1. Bellows type, pre-charged compression chamber, stainless steel casing and bellows.
   2. Provide sizes complying with PDI-WH-201.

B. Water Shock Absorbers (Water Hammer Arresters):
   1. Manufacturers:
      a. Watts.
      b. Smith (Jay R.) Manufacturing Company.
      c. Wade, Division of Tyler Pipe.
      d. Zurn Industries, Inc., Hydromechanics Division.
      e. Or equal.

C. Piston Type water shock absorbers, Type L copper casing, pressure rated for 250 psi, tested and certified in accordance with PDI-WH-201.

D. Water Meter: Water meter will be furnished by Owner and installed by Contractor.

2.13 FIXTURES

A. General:
   1. Provide factory fabricated fixtures of size, type, rating, and capacity indicated.
   2. Where not indicated, provide proper selection, as determined by CONTRACTOR, to comply with installation requirements.
   3. Provide sizes and types matching piping and equipment connections.

4. The finish of fittings, accessories, and supplies exposed to view shall be chromium-plated per ASME A112.187.1M.
5. Fixtures and faucets shall meet the requirements of the Reduction of Lead in Drinking Water Act.
6. Use of manufacturer's name and model or catalog number is for purpose of establishing standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with manufacturers listed in this section.

B. HANDICAPPED WATER CLOSETS (WC-1):
1. Kohler Kingston K-4325, wall supported, flush valve, white vitreous china siphon jet elongated bowl, with 2-1/8 in. passageway, 1-1/2 in. top spud, 1.28 gpf or 1.6 gpf depending on flushometer specified, ASME A112.19.2.
2. Kohler Lustra K-4666-C, white elongated closet seat, with open front, check hinge.
3. Sloan 113-1.6, 1.6 gpf flush valve with 1 in. IPS stop, vacuum breaker, ADA Compliant non-hold open handle, adjustable tailpiece, and 1-1/2 in. spud coupling conforming to ASSE 1037.
4. J.R. Smith 0100-0600 Series carrier.

C. URINAL (U-1):
1. Kohler Bardon K-4904-ET, white vitreous china, wall hung, washout flushing, 3/4 in. top spud with beehive strainer, 0.125 gpf to 1.0 gpf.
2. Sloan 186-0.5, 0.5 gpf flush valve with 3/4 in. IPS stop, vacuum breaker, ADA Compliant non-hold open handle, adjustable tailpiece, and 3/4 in. spud coupling conforming to ASSE 1037.
3. J.R. Smith 0600 Series carrier.

D. WALL HUNG LAVATORY (L-1):
1. Kohler Greenwich K-2032, white vitreous china 20 in. by 18 in. drilled for concealed arm carrier.
2. Chicago Faucet No. 802-665ABCP, manual metering faucet, 4 in. centers, 2.2 gpm aerator, vandal proof metering push handles, adjustable cycle time closure, integral spout, chrome plated.
3. Kohler K-8999, 1-1/4 in. by 1-1/2 in. cast brass p-trap with cleanout plug, chrome plated.
4. Kohler K-7131-A, 1-1/4 in. cast brass offset drain with grid strainer, chrome plated.
5. Kohler K-7605-P-CP, 3/8 in. IPS supply connections, chrome plated brass, four-arm handle stop.
6. J.R. Smith 0700-0900 Series carrier.
7. Kohler K-99799, thermostatic tempering valve, (set at 100°F), built-in check valves on cold water inlet and hot water inlet, tamper resistant locking nut to prevent accidental mis-adjustment.
8. Truebro Lav Guard 2, under sink piping covers, rigid high impact stain resistant white PVC, 1/8 in. nominal wall thickness, tear to fit trim feature, E-Z grip fasteners, fits all 1-1/4 in. or 1-1/2 in. tubular P-traps and 3/8 in. or 1/2 in. angle stop assemblies.

E. SERVICE SINK (SS-1):
1. Kohler Bannon K-6719, 24 in. by 20 in., wall mounted, acid resistant enameled cast iron, blank back, with stainless steel rim guard.
2. Kohler K-6673, adjustable trap for 3 in. iron pipe connection with cleanout plug and strainer.

3. Chicago Faucet No. 917-RCF, service sink faucet with rough chrome finish, raised atmospheric vacuum breaker, vandal proof lever handles, double pipe supports, rigid spout with hose threads, pail hook and wall brace.
4. Provide (2) 1/2 in. by 60 in. rough chrome finish riser pipes for each faucet.
5. Provide 4-ft length of garden hose with female fitting for each faucet.

F. EMERGENCY SHOWER AND EYE/FACE WASH (ESEW-1):
1. Manufacturers:
   a. Haws Model 8330.
   b. Bradley
   c. Guardian.
   d. Or equal.
2. Barrier free, 1-1/4 inch stainless steel pipe stand with safety yellow coating, chrome-plated brass stay-open shower and eye/face wash ball valves, plastic shower head, halo eye/face wash with stainless bowl and cover, stainless steel activation handle.
3. Thermostatic Mixing Valve: Model 9201H or equal, liquid filled thermostat, integral strainer, check stops on inlets, adjustable set point within temperature range, accurate temperature control, built-in cold water by-pass, positive shut-off of hot supply when cold supply is lost, dial thermometer and wall mounting bracket.
4. Alarm Flow Switch Model SP154DPDT.
5. Certification: Emergency eyewash/ showers shall comply with ANSI Z358.1-2014.

G. EMERGENCY SHOWER AND EYE/FACE WASH - FREEZE PROTECTED (ESEW-2):
1. Manufacturers: Haws Corporation; Model 8317CTFP
   a. Haws Corporation; Model 8317CTFP
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Speakman Company.
   e. Or equal.
2. Piping: Galvanized steel.
   a. Unit Supply: NPT 1-1/4 inch.
   b. Mounting: Floor mounted.
3. Heating System: Electric, 120V ac; insulation enclosed in a protective jacket with thermostat.
   a. Design Ambient Temperature: Minus 30 deg F.
4. Shower:
   a. Shower Capacity: Not less than 20 gpm for at least 15 minutes. Maximum flow not to exceed 25 gpm when within compliant pressure ranges.
   b. Supplied with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Pull rod.
   d. Shower Head: 10-1/2-inch- diameter, plastic.
5. Eye/Face Wash Unit:
   a. Capacity: Not less than 3 gpm for at least 15 minutes.
   b. Control-Valve Actuator: Paddle.
6. Appurtenances:
   a. Flow switch with dry contacts for remote alarm.

H. WALL-MOUNTED EMERGENCY SHOWER (ES-1)
1. Manufacturers:
   a. Haws Model 8133H.
   b. Bradley

c. Guardian.
d. Or equal.

2. Horizontally mounted drench shower shall include stainless steel showerhead with 20 gpm flow control, type 316 stainless steel schedule 40 pipe and fittings. Includes stainless stay-open ball valve, pull rod with triangular handle, universal sign and 1" NPT supply.
3. Thermostatic Mixing Valve: Model 9201E or equal, liquid filled thermostat, integral strainer, check stops on inlets, adjustable set point within temperature range, accurate temperature control, built-in cold water by-pass, positive shut-off of hot supply when cold supply is lost, dial thermometer and wall mounting bracket.
4. Alarm Flow Switch Model SP154DPDT.
5. Certification: Emergency eyewash/ showers shall comply with ANSI Z358.1-2014.

I. WALL-MOUNTED EMERGENCY EYE/FACE WASH (EEW-1)

1. Manufacturers:
   a. Haws Model 7360.
   b. Bradley
   c. Guardian.
   d. Or equal.
2. Wall-mounted eye/face wash shall include a 11" round stainless-steel bowl with 3.7 gpm flow control, type 316 stainless steel schedule 40 pipe and fittings. Includes stainless stay-open ball valve, in-line 50 mesh strainer, pop-off dust cover, universal sign and 1/2" NPT supply.
3. Thermostatic Mixing Valve: Model 9201EW or equal, liquid filled thermostat, integral strainer, check stops on inlets, adjustable set point within temperature range, accurate temperature control, built-in cold water by-pass, positive shut-off of hot supply when cold supply is lost, dial thermometer and wall mounting bracket.
4. Alarm Flow Switch Model SP154DPDT.
5. Pipe 1-1/2" drain down to 12" above floor.
6. Certification: Emergency eyewash/ showers shall comply with ANSI Z358.1-2014.

2.14 PLUMBING EQUIPMENT

A. ELECTRIC WATER HEATER: (EWH-1)

1. Manufacturers:
   a. Rheem Model E175A-72-G.
   b. A.O. Smith.
   c. American Standard
   d. Ruud
   e. State
   f. Or equal.
2. Commercial water heater, heavy duty, 175 gal storage capacity, seamless glass lined welded tank construction, ASME construction certified, maximum hydrostatic working pressure of 160 psi, foam insulation, dual magnesium anode rods for corrosion resistance, 2-1/2" NPT water connections, cold water bottom side inlet, hot water top outlet, 72-kw or 245,678 Btu/hr. electric input, recovery of 298 gal/hr. at 100° F rise, stainless steel "screw-in" type elements, immersion thermostats, internal power circuit fusing, control circuit fusing, magnetic contactors, 120Vcontrol circuit transformer and surface mounted thermostat or immersion thermostats with manual reset high limit control, and System Sentinal diagnostic panel with LED's that correspond to the number, location, and status of each heating element.

3. Water heater shall meet the thermal efficiency and standby loss requirements of the U.S. Department of Energy and current edition ASHRAE/IES 90.1.
4. Pre-wired, accessible control box with multiple knock-outs on side in size selections to match NEC, grounding screw, terminal block, 480V/3ph power supply.
5. Adjustable water temperature up to 180°F, set water temperature at 160°F. Contractor shall verify that all plumbing fixtures are provided with Thermostatic Mixing Valves.
6. Provide properly sized ASME pressure and temperature relief valve.
7. Full-port, full-flow, brass drain valve.
8. Provide thermal expansion tank: Amtrol Model ST-12C or equal.
9. Provide vacuum relief valve: Watts Model LFN-36-M1-3/4" or equal.
10. Manufacturer 3-year limited warranty on tank and1-year limited parts warranty.

B. SUMP PUMPS (SP-1 & SP-2):
1. Manufacturers:
   a. Zoeller Pump Co.
   b. Weil.
   c. Hydr-O-Matic, Marley Pump Co.
   d. Or equal.
2. Pump Selection:
   a. Pumps shall operate at or near point of peak efficiency allowing for operation at capacities of approximately 25% beyond design capacity.
   b. Design impeller diameter so design capacity of each pump (gpm and TDH) shall not exceed 90% of capacity obtainable with maximum impeller diameter at design speed for that model and motor RPM.
   c. Pump curve shall be continuously rising from maximum capacity up to shutoff point.
   d. Motor shall be non-overloading at any point on the curve.
3. General:
   a. Motors:
      1) Comply with requirements of Sections 26 0505 and 26 2000, except as modified herein.
      2) Stainless steel impeller shaft with permanently lubricated bearings.
      3) Cast iron motor housing and volute, factory mounted and finished with corrosion resistant epoxy coating.
      4) Sealed 20 ft power cord with rated twist-lock plug at control panel.
   b. Sump Basin
      1) Provide cast-in-place reinforced concrete sump basin as shown on drawings, integral to the building structure as detailed on Structural drawings. Submit shop drawings for approval.
      2) Provide aluminum or cast-iron gastight cover with threaded or flanged openings to accommodate pump discharge piping, vent connection, and rubber grommeted fittings to pass power and float cords. Cover to include bolt-down hand holes to permit removal of either pump and servicing of floats, without removing full cover.
   c. Alternator Control Panel:
      1) Sequence alternator control panel, factory wired and tested, except as modified herein.
      2) Wall mounted NEMA 4 enclosures for non-rated areas.
      3) 2 combination magnetic starters, green "pump run" indicator lights, Hand/Off/Auto switch for each pump, high water alarm (with light, horn and silencer), non-powered contact for remote alarm, and automatic alternator

circuit which will change pump lead after each draw-down cycle, except as modified herein.

4) Control circuitry shall be 115v, 1 ph, 60 Hz with integral control transformer factory wired.

5) Switches, lights, alternators, and panel components shall be in accordance with requirements of Section 26 0900.

6) Remote Alarm; Auxiliary set of dry contacts to be sent to SCADA by Division 40.

d. Float Switch and Float:

1) 4 strap-mounted mercury float switches, except as modified herein.

2) Floats shall be double wall, totally sealed, chemical-resistant plastic with internal molybdenum contact mercury switch and 20 ft neoprene jacketed power cord with rated twist-lock plug, except as modified herein.

4. Duplex Pump System (SP-1 and SP-2):

a. Zoeller high head submersible effluent pumps. Rated for continuous duty and capable of passing 1/2 in. solids. Shutoff head at least 50% greater than TDH at scheduled rated flow.

1) SP-1: Model 151 - Rated for continuous duty at 29 gpm against 20 ft TDH and capable of passing 1/2 in. solids. 1/3 horsepower at 3450 rpm, 115 Volts, single phase.

2) SP-2: Model 161 - Rated for continuous duty at 79 gpm against 20 ft TDH and capable of passing 1/2 in. solids. 1/2 horsepower at 3450 rpm, 115 Volts, single phase.

b. Pump Control Settings:

1)	6" Drain Invert EL.	742.50
2)	High Water Alarm EL.	743.00
3)	Both Pumps On EL.	742.00
4)	Lead Pump On EL. (Pumps Alternate)	741.50
5)	Both Pumps Off EL.	741.17
6)	Bottom of Sump EL.	740.50

C. DOMESTIC HOT WATER RECIRCULATING PUMPS (RP-1):

1. Manufacturers:

a. Taco

b. Armstrong

c. Bell & Gossett

d. Grundfos

e. Watts

f. Or equal.

2. RP-1; Model 008-B6, Plumb n' Plug, pre-wired domestic water recirculating pump, 3/4-in sweat connection, 1/25-hp, 115V/1-ph, 60 Hz., 0.84 amps, 7-day digital timer controller, isolation ball valves, unions, discharge check valve, air purge valve. Rated for continuous duty at 12 gpm against 5 ft TDH.

2.15 INSULATION

A. Fibrous Glass Insulation:

1. Manufacturers:

a. Owens-Corning.

b. Manville.

c. Or equal.

2. 3.5 lb density with laminated white vapor barrier jacket, thickness as scheduled.
3. Ratings not exceeding flame spread of 25 and smoke developed of 50 (Test Method ASTM E84).
4. Fiberglass Insulation PVC Jacketing: ASTM C547, high temperature, preformed, jacket with matching pre-molded PVC fitting covers. (For use in chemical room spaces.)

B. Flexible Unicellular Pipe Insulation (Below Grade):
1. Manufacturers:
a. Manville.
b. Rubatex.
c. Or equal.
2. ASTM C534, Type I, density 4.5 to 8.5 pcf., thickness as scheduled.
3. Maximum ASTM C96 permeability = 0.3 perm-in.
4. Maximum k = 0.30 Btu-in./hr-sq ft-° F, at 75° F to 200° F, with fittings sealed at joints.

2.16 PIPING SPECIALTIES

A. Mechanical Sleeve Seals:
1. Manufacturers:
a. Thunderline Corporation.
b. Or equal.
2. Modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Select to withstand 40-ft hydrostatic head of water.

B. Pipe Sleeves and Wall Collars:
1. Provide pipe sleeves and wall collars of one of following:
a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from following gauges; 3 in. and smaller; 20 ga; 4 in. to 6 in. 16 ga; over 6 in. 14 ga.
b. Steel Pipe: Fabricate from Schedule 40 carbon steel pipe. Provide welded center flange and hot-dipped galvanized finish for water stoppage.
c. Iron Pipe: Provide cast iron or ductile iron pipe with integrally cast intermediate collar in exterior, water supporting, and water retaining walls and slabs.
d. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.

C. Dielectric Unions:
1. Manufacturers:
a. B & K Industries, Inc.
b. Rockford, Eclipse Division.
c. Or equal.
2. Provide standard products recommended by manufacturer for use in service indicated which effectively isolate ferrous from nonferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

D. Pipe Escutcheons:
1. Manufacturers:
a. Jones Manufacturing Co., Inc.
b. Or equal.

2. Provide pipe escutcheons with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls or ceilings and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas. Prime paint finish for unoccupied areas.
3. Pipe Escutcheons for Moist Areas: For waterproof floors and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
4. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.
5. Pipe Escutcheons for Chemical Areas: Provide 316 stainless steel escutcheons.

PART 3 - EXECUTION

3.1 GENERAL

A. Trench, backfill, and compact in accordance with Section 31 2305.

B. Install pipe hangers, supports, and anchors in accordance with Section 22 0529.

C. Install wall pipes, sleeves, and seals in accordance with this section.

3.2 PIPING INSTALLATION

A. General:
1. Install pipe, tube, and fittings in accordance with recognized industry practices achieving permanently leakproof piping systems, capable of performing each indicated service without piping failure.
2. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment.
3. Reduce sizes (where indicated) by use of reducing fittings.
4. Align piping accurately at connections, within 1/16 in. misalignment tolerance.
5. Comply with ASME B31.9 - Building Service Piping.
6. Installation of water piping must comply with IAMPO Installation Standard 20 98; Including provisions for expansion and contraction.

B. Pipe Locations:
1. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain), and avoid diagonal runs wherever possible.
2. Orient horizontal runs parallel with walls and column lines.
3. Locate runs, as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and equipment.
4. Hold piping close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building; limit clearance to 1/2 in. where furring is shown for enclosure to concealment of piping, but allow for insulation thickness, if any.
5. Where possible, locate insulated piping for 1.0 in. clearance outside insulation.
6. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

C. Electrical Equipment Spaces:

1. Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable.
2. Install drip pan under piping that must be run through electrical spaces.

D. Expansion Compensation:
1. Install piping including mains, branches, and runouts with sufficient offsets to allow for free expansion and contraction and sufficient to prevent leaks and overstressing of piping system.

E. Bellows Air Cushion:
1. Install units at top of each riser and at end of each branch, as required, to comply with PDI-WH-201.

F. Installation of Waste, Vent and Storm Piping:
1. Install horizontal piping on constant grade, avoiding pockets. Minimum grade of 1/8 in./ft for mains and 1/4 in./ft for branches.
2. Cleanouts:
   a. Install cleanout plugs at each 90° change in direction in suspended horizontal piping.
   b. Where not otherwise indicated, install cleanouts at 50 ft intervals in piping 3 in. and smaller, and 100 ft intervals in piping 4 in. and larger.
   c. Install floor and wall cleanouts at locations indicated.
3. Flashing Flanges:
   a. Install flashing flange and clamping device with each cleanout passing through waterproof membrane.
4. Testing:
   a. Test waste and vent piping system in accordance with the Section 22 0810 – Testing Piping Systems and the Ohio Plumbing Code.

3.3 VALVES

A. Except as otherwise indicated, comply with following requirements.
1. Install valves where required for proper operation of piping and equipment, include shut-off valves in branch lines where necessary to isolate sections of piping. Locate valves so accessible and separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable.

B. Insulation: Where insulation is indicated, provide extended stem valves arranged to receive insulation.

C. Select and install ball valves as specified in applicable system sections. When not otherwise specified, furnish and install in accordance with following.

D. Two-Piece Construction:
1. Branch main isolation.

3.4 FIXTURES

A. Water Heaters:
1. Install in accordance with manufacturer's written instructions in locations shown. Pipe discharge from relief valve down to 6 in. from floor.

B. Plumbing Fixtures:
   1. Install in accordance with manufacturer's written instructions and as called for and required by codes.
   2. Verify locations and coordinate with architectural designs and other devices and equipment, as approved by ENGINEER before roughing-in connections.
   3. Operation of fixtures shall be tested for proper operation and adjusted for field connections and service use, as required.

C. Sump Pumps:
   1. Install in accordance with manufacturer's written instructions, provide discharge with union and check valves.

D. Domestic Hot Water Recirculating Pumps:
   1. Install in accordance with manufacturer's written instructions, provide isolation ball valves, unions, discharge check valve, and air purge valve.

3.5 PLUMBING PIPING SYSTEM INSULATION

A. Install in accordance with manufacturer's written instructions, install after testing and acceptance of piping system, and insulate each continuous run of piping with full-length units. Do not use cut pieces or scraps abutting each other, maintain integrity of vapor barrier jacket on pipe insulation.

B. Insulation Omitted: Omit insulation on exposed plumbing fixture runouts from faces of wall or floor to fixture; on unions, flanges, strainers, flexible connections, and expansion joints.

C. Cover valves, fittings, and similar items in each piping system with equivalent thickness and composition of insulation, install factory molded or precut on job fabricated units.

D. Install insulation on domestic hot and cold.

E. Provide PVC jacketing with formed fitting covers on all plumbing piping in chemical room spaces.

F. Replace damaged insulation which cannot be repaired.

G. Cold Piping (40°F to 55°F):
   1. Application Requirements: Insulate following cold piping systems.
      a. Domestic cold water piping systems.
      b. Interior above ground storm water piping systems.
   2. Insulate each piping system specified above with 1 of following types and thicknesses in accordance with Schedule 1.
      a. Insulation: Fiberglass with vapor barrier jacket (above grade) (PVC over-jacket where exposed).
      b. Insulation: Flexible unicellular (buried).

H. Hot Piping (120°F to 200°F):
   1. Application Requirements: Insulate following hot piping systems.
      a. Domestic hot water piping systems.
      b. Domestic hot water return piping systems.
   2. Insulate each piping system specified above with 1 of following types and thicknesses in accordance with Schedule 1.

a. Insulation: Fiberglass with vapor barrier jacket (above grade) (PVC over-jacket where exposed).
b. Insulation: Flexible unicellular (buried).

3.6 PIPING SPECIALTIES

A. Pipe Sleeves and Wall Collars: Install pipe sleeves of types indicated where piping passes through walls, floors, and roofs. Verify size, location, and type of penetration prior to pouring concrete or placing masonry. Do not install sleeves through structural members of work, except as shown on Drawings or as approved by ENGINEER. Install sleeves accurately centered on pipe runs. Size sleeves so piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion but not less than pipe sizes larger than piping run. Where insulation includes vapor barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface except floor sleeves. Extend floor sleeves 2 in. above level floor finish. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves. Center sleeve intermediate collar seepage ring in wall or slab and align with bolt holes in flanges straddling centerlines horizontally and vertically. Do not allow reinforcing steel to contact wall pipes.
1. Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
2. Install iron pipe sleeves at exterior penetrations; above and below grade before concrete or masonry placed.
3. Install steel or plastic pipe sleeves except as otherwise indicated.

B. Sleeve Seals: Install in annular space between pipes and sleeve walls in exterior water supporting walls, foundation, exterior walls, and retaining walls to form watertight seals.

C. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration exposed to view and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

D. Dielectric Unions: Install at each piping joint between ferrous and nonferrous piping. Comply with manufacturer's installation instructions.

3.7 CLEANING AND STERILIZATION

A. Clean and sterilize domestic water piping system as required by health authorities having jurisdiction and in accordance with Ohio Plumbing Code.

B. Plate count must be less than 10 spc/ml.

3.8 TESTING PIPING SYSTEMS

A. The plumbing systems shall be tested, in accordance with Ohio Plumbing Code.

SCHEDULE 1 TO SECTION 22 0010 Insulation Thicknesses in In. for Pipe Sizes							
Piping System Types	**Fluid Temp. Range °F.**	**Runouts up to 2 in. (2)**	**1 in. and Less**	**1-1/4 to 2 in.**	**2-1/2 to 4 in.**	**5 to 6 in.**	**8 in. and Larger**
Hot Systems:							
Low Temp.	120-200	1	1	1	1-1/2	1-1/2	1-1/2
Cold Systems:							
Plumbing	Any	3/4	3/4	1	1	1	1

END OF SECTION 22 0010

SECTION 22 0529

PIPE HANGERS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System of pipe supports and anchors with necessary inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, and other accessories.

1.2 DEFINITIONS

A. Submerged: At or below point 1 ft., 6 in. above peak (maximum) water surface elevations in water holding structure.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Design, detail and installation of pipe support system shall be responsibility of CONTRACTOR.
   2. Pipe support system components shall withstand dead loads imposed by weight of pipes filled with water plus insulation, plus live loads due to thermal expansion, vibration, internal test pressures, and have minimum safety factor of 5.
   3. Absence of pipe supports and details on Drawings shall not relieve CONTRACTOR of responsibility for providing them throughout plant.
   4. Supply design loading criteria to pre-engineered metal building manufacturer for piping supported from steel members.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Pipe supporting system, including manufacturer’s product data, dimensions, sizes, types, location, maximum loadings, thrust anchorage, and installation instructions.

B. Submit in accordance with Section 01 3300.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fee and Mason.

B. Grinnell.

C. Carpenter-Patterson.

D. Unistrut.

E. Superstrut.

F. Or equal.

2.2 GENERAL

A. MSS types indicated are typical of types and quality of standard pipe supports and hangers to be employed.

B. Provide factory fabricated piping hangers and supports, clamps, hanger rod attachments, building attachments, saddles, shields, thrust anchorage, and other miscellaneous products of MSS SP-69 type indicated or shop fabricated supports; comply with MSS SP-58 and manufacturer's published product information. Where MSS type not indicated, provide proper selection for installation requirements and comply with MSS SP-69, MSS SP-89 and manufacturer's published product information.

2.3 MATERIALS

A. Hangers, rods, clamps, protective shields, metal framing, support components, and hanger accessories shall be galvanized unless otherwise noted.

B. Hangers, rods, clamps, protective shields, metal framing, support components, and hanger accessories in submerged locations in wet wells, tanks, channels or tank covers, locations outdoors, and located in Chemical Rooms shall be Type 316 stainless steel.

2.4 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General:
1. Unless otherwise shown or specified, hangers for 2-1/2 in. and smaller pipe shall be split-ring, adjustable swivel, clevis or roller type, hangers for 3 in. pipe or greater shall be clevis or roller type.
2. Hangers for use with spring supports shall be split-ring or clamp type.
3. Hangers for fiberglass reinforced pipe shall be saddle type.
4. Each hanger shall be designed to permit at least 1-1/2 in. vertical adjustment after installation.

B. Adjustable Swivel Split-Ring Hanger: MSS Type 6.

C. Adjustable Clevis Hanger: MSS Type 1, fabricated from steel.

D. Adjustable Band Hanger: MSS Type 7, fabricated from steel.

E. Adjustable Swivel-Band Hanger: MSS Type 10.

F. Clamp: MSS Type 4.

G. Single Roll Support: MSS Type 41, including axle roller and threaded sockets.

H. Adjustable Roller Hanger: MSS Type 43, including axle roller and clevis.

I. Roll/Stand: MSS Type 44, including roller, stand, and axle.

J. Adjustable Roll/Base: MSS Type 46, including roller, adjustable base, and stand.

K. Steel Brackets: Welded structural steel shapes complying with following.
   1. Light Duty: MSS Type 31.
   2. Medium Duty: MSS Type 32.
   3. Heavy Duty: MSS Type 33.

L. Adjustable Saddle Support:
   1. MSS Type 38, including saddle, pipe, and reducer.
   2. Fabricate base support from steel pipe and include cast iron flange or welded steel plate.

M. Stanchion Saddle Support:
   1. MSS Type 37, including saddle and U-bolt.
   2. Fabricate base support from steel pipe and include cast iron flange or welded steel plate.

N. Strap or wire hangers not acceptable.

2.5 VERTICAL PIPING CLAMPS

A. 2-Bolt Riser Clamp: MSS Type 8, galvanized or plastic coated.

B. 4-Bolt Riser Clamp: MSS Type 42, include pipe spacers at inner bolt holes, galvanized or plastic coated.

2.6 HANGER RODS AND ATTACHMENTS

A. Hanger Rods:
   1. ASTM A36/A 36M, threaded both ends or continuous threaded.
   2. Rods shall conform to following sizes.

Pipe Size	Minimum Rod Diameter (in.)
Up to 2 in.	3/8
2-1/2 in and 3 in.	1/2
4 in.	5/8
6 in.	3/4
8 in. to 12 in.	7/8
14 in. and Up	1
Trapeze Hangers	As Required

B. Turnbuckles: MSS Type 13.

C. Weldless Eye Nut: MSS Type 17.

D. Eye Socket: MSS Type 16.

E. Clevis: MSS Type 14.

2.7 BUILDING ATTACHMENTS

A. Individual Concrete Inserts:

1. MSS Type 18, malleable iron.
2. MSS Type 19, steel.
3. Minimum Safe Load: 1,100 lbs.

B. Continuous Concrete Inserts:
1. Unistrut, P-3200 Series.
2. Fee and Mason, Figure 9000.
3. Superstrut.
4. Or equal.

C. Top Beam C-Clamp: MSS Type 19.

D. C-Clamps: MSS Type 23, steel.

E. Single-Side Clamp: MSS Type 25.

F. Top I-Beam Clamp: MSS Type 25.

G. Side Beam Clamp: MSS Type 20.

H. Concrete Anchors:
1. Comply with Section 05 0533.
2. Minimum Safety Factor: 5.

2.8 SADDLES AND SHIELDS

A. Protection Saddles: MSS Type 39.

B. Protection Shields: MSS Type 40.

C. Wood Insulation Saddle:
1. Elcen Metal Products Company.
2. Or equal.

2.9 MISCELLANEOUS MATERIALS

A. Metal Framing Systems:
1. Unistrut, galvanized.
2. Fee and Mason, galvanized.
3. Or equal.

B. Shop-Fabricated Anchors and Supports:
1. Steel Plates, Shapes, and Bars: ASTM A36/A 36M.
2. Restraining Rods: ASTM A307.

PART 3 - EXECUTION

3.1 GENERAL

A. Proceed with installation of hangers, supports, and anchors after required building structural work is complete and concrete support structure has reached 28 day compressive strength as specified in Section 03 3000.

B. Install hangers, supports, clamps, and attachments from building structure. Comply with MSS SP-69. Group parallel runs of horizontal piping to be supported together on trapeze type hangers where possible.

C. Install supports to provide indicated pipe slopes and maximum pipe deflections allowed by ASME B31.1 are not exceeded.

D. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

E. Do not support piping from other piping.

F. Prevent contact between dissimilar metals. Where concrete or metal pipe support is used, place 1/8 in. thick teflon, neoprene rubber or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and support.

G. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, plastic coated or by other recognized industry methods. Electrician's tape is not an acceptable isolation method.

H. Apply anti-seize compound to nuts and bolts.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

A. Support piping from structural framing, unless otherwise noted.

B. Concrete Inserts:
   1. Locate inserts so total load on insert does not exceed manufacturer's recommended maximum load. Location of inserts shall be approved by ENGINEER.
   2. Where necessary to anchor supports to hardened concrete or completed masonry, use concrete anchors.

C. Attach to structural steel with beam clamps.

3.3 THRUST ANCHORS AND GUIDES

A. Thrust Anchors:
   1. For suspended piping, center thrust anchors as closely as possible between expansion joints and between elbows and expansion joints. Anchors shall hold pipe securely and be sufficiently rigid to force expansion and contraction movement to take place at expansion joints or elbows and preclude separation of joints.
   2. Provide thrust anchors as required to resist thrust due to changes in diameter or direction or dead ending of pipe lines. Anchorage shall be required wherever bending stresses exceed allowable for pipe. Wall pipes may be used as thrust anchors.
   3. Restraining rod size and number shall be as shown on Drawings.

B. Pipe guides shall be provided adjacent to sliding expansion joints in accordance with recommendations of National Association of Expansion Joint Manufacturers.

3.4 PIPE SUPPORT

A. Spacing:

Type of Pipe	Maximum Pipe Support Spacing (ft)
Steel	
10 in. and over	22
8 in.	19
6 in.	17
5 in.	16
4 in.	14
3-1/2 in.	13
3 in.	12
2-1/2 in.	11
2 in.	10
1-1/2 in.	9
1 in.	7
3/4 in.	6
1/2 in.	5
Copper	
4 in.	12
3-1/2 in.	11
3 in.	10
2-1/2 in.	9
2 in.	8
1-1/2 in.	8
1-1/4 in.	7
1 in.	5
3/4 in.	5
1/2 in.	5
Plastic (Schedule 80 at 100°F)	
8 in.	4
6 in.	4
4 in.	4
3 in.	4
2 in.	4
1-1/2 in.	4
1 in.	4
3/4 in.	4
1/2 in.	4
(For plumbing application plastic piping shall be supported at maximum of 4 ft-0 in. spacing.)	
Stainless Steel	
1 in. and smaller	6

Type of Pipe	Maximum Pipe Support Spacing (ft)
1-1/2 in. through 4 in.	8
6 in.	8
8 in. and 10 in.	10
12 in.	10
14 in.	12
16 in.	12
18 in. and larger	14
Cast Iron and Ductile Iron	
1 in. and smaller	6
1-1/4 in. through 2-1/2 in.	8
3 in. and 4 in.	10
6 in.	12
8 in.	12
10 in. and 12 in.	14
14 in.	16
16 in. and 18 in.	16
20 in.	18
24 in. and larger	18
(For cast iron soil pipe plumbing applications, support at 5 ft-0 in. spacing.)	

B. Where piping of various sizes is to be supported together, space supports for smallest pipe size or install intermediate supports for smaller diameter pipe.

C. Provide minimum of 2 pipe supports for each pipe run.

D. Where piping connects to equipment, support by pipe support and not by equipment, unless approved by equipment manufacturer.

E. Unless otherwise shown or authorized by ENGINEER, place piping running parallel to walls approximately 1-1/2 in. out from face of wall and at least 3 in. below ceiling.

F. Pedestal pipe supports shall be adjustable with stanchion, saddle, and anchoring flange.

G. Piping supports for vertical piping passing through floor sleeves shall be galvanized steel riser clamps.

H. Piping passing through sleeves or openings in interior wall sleeves shall be carried by supports or hangers. Do not rest on wall.

I. Support piping in manner preventing undue strain on valve, fitting or equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to nonrigid joints, and where otherwise shown. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

J. Install supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Piping shall be free to move when expands or contracts, except where fixed anchors are indicated. Where adequate hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 in./100 ft for each 100°F change in temperature exceed 1/2 in., provide approved roller supports.

L. Support piping 6 in. and larger on trapeze hangers with rollers.

3.5 INSULATED PIPING

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8 in. and over, install wood insulation saddles.

C. Where insulation without vapor barrier is indicated, install protection saddles on piping 2 in. and larger.

3.6 BURIED PIPING

A. Provide unlugged bell and spigot or bell tees, Y-branches, and bends deflecting 11-1/4° or more and plugs with reaction blocking, anchors, joint harness or other acceptable means for preventing movement of pipe and joints caused by internal pressure.

B. Concrete Blocking:
1. Extend from fitting to solid undisturbed earth and installed so joints accessible for repair.
2. Bearing area of concrete reaction blocking shall be as shown on Drawings.
3. If adequate support against undisturbed ground cannot be obtained, install metal harness anchorages consisting of steel rods across joint and securely anchored to pipe and fitting or other adequate anchorage facilities to provide necessary support.
4. Should lack of solid vertical excavation face be due to improper trench excavation, cost of furnishing and installing metal harness anchorages in excess of Contract value of concrete blocking replaced by such anchorages shall be borne by CONTRACTOR.

C. Provide reaction blocking, anchorages or other supports for fittings installed in fills or other unstable ground or above grade as shown on Drawings.

END OF SECTION 22 0529

SECTION 22 0553

PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic pipe markers.
   2. Painted ductwork identification materials.
   3. Plastic duct markers.
   4. Underground type plastic line marker.
   5. Valve tags.
   6. Plastic equipment markers.
   7. Piping system color coding schedule.

B. Identification furnished as part of equipment is specified as part of equipment assembly in other sections and shall comply with requirements of this section.

C. Refer to Division 26 sections for identification requirements of electrical and instrumentation work, not work of this section.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required. Submit listing of each flow stream identifier with associated color coding.

B. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

C. Shop Drawings:
   1. Submit valve schedule for each piping system. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves intended for emergency shut-off and similar special uses, by special flags in schedule margin. In addition to mounted copies, furnish extra copies for maintenance manuals.

D. Submit in accordance with Section 01 3300.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Regulatory Requirements:
   1. ANSI Standards: Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Allen Systems, Inc.

B. Brady (W.H.) Company, Signmark Division.

C. Marking Services, Inc.

D. Industrial Safety Supply Company, Inc.

E. Seton Name Plate Corporation.

F. Or equal.

2.2 MECHANICAL IDENTIFICATION MATERIALS

A. Provide manufacturer's recommended products as specified for each application.

B. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category.

C. Bands, markers, and identification materials used in all locations shall be rated for exterior application and suitable for withstanding occasional wash down.

2.3 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations, and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or if not indicated, as recommended by manufacturers or required for proper identification and operation and maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown or specified, provide identification indicating individual system number as well as service (i.e., Boiler No. 3, Air Supply Unit No. 10-ASU-2, etc.).

2.4 PLASTIC PIPE MARKERS

A. Snap-On Type: Provide preprinted, semi-rigid snap-on, color coded pipe markers complying with ASME A13.1.

B. Pressure Sensitive Type: Provide preprinted, permanent adhesive, color coded, pressure sensitive vinyl pipe markers complying with ASME A13.1. Dot matrix printing is not acceptable.

C. Small Pipes: For external diameters less than 6 in. (including insulation, if any), provide full band pipe markers, extending 360 degrees around pipe at each location, fastened by 1 of following methods:
   1. Snap-on application of pre-tensioned, semi-rigid plastic pipe marker.
   2. Adhesive lap joint in pipe marker overlap.

3. Taped to pipe (or insulation) with color coded plastic adhesive tape not less than 4 in. wide, full circle at both ends of pipe marker, tape lapped 1-1/2 in.

D. Large Pipes: For external diameter 6 in. and larger (including insulation, if any), provide either full band or strip type pipe markers not narrower than 3 times letter height (and of required length), fastened by one of following methods:
1. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 4 in. wide, full circle at both ends of pipe marker, tape lapped 3 in.
2. Strapped to pipe (or insulation) application of semi-rigid type with manufacturer's standard stainless-steel bands.

E. Lettering: Comply with piping system nomenclature as specified, scheduled or shown and abbreviate only as necessary for each application length, and only with approval of ARCHITECT/ENGINEER. Lettering height shall be as follows:

Outside Pipe Diameter (in.)	Minimum Letter Height (in.)	Minimum Length of Marker (in.)
3/4 to 1-1/4	1/2	8
1-1/2 to 2	3/4	8
2-1/2 to 6	1-1/4	12
8 to 10	2-1/2	24
over 10	3-1/2	32

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

G. Label and band colors in accordance with Section 09 9600, and the following:
1. Lettering and arrows:
   a. Black on yellow background for inherently hazardous materials.
   b. White on blue (gaseous) or green (liquid) for low hazard materials.
   c. White on red background for fire quenching materials.
2. Banding: Colors and band spacing as scheduled or as shown on Drawings.

2.5 UNDERGROUND TYPE PLASTIC LINE MARKERS

A. Permanent, bright colored, continuous printed plastic tape, intended for direct burial service; not less than 6 in. wide by 4 mils thick. Provide tape with printing most accurately indicating type of service of buried pipe.

B. Provide multi-ply tape consisting of solid aluminum foil core between 2 layers of plastic tape.

2.6 PLASTIC EQUIPMENT MARKERS

A. 2-ply, 1/8 in. thick laminated engraved plastic.
1. Color: Black letters on white background.

B. Nomenclature: Include following, matching terminology on schedules as closely as possible:
1. Equipment name (i.e. electric water heater No. 1).
2. Equipment Tag No. (i.e. EWH-1).

C. Size: Provide approximate 3 in. by 6 in. (minimum) for equipment.

1. 1 in. high letters for equipment tag number.
2. 1/2 in. high letters for descriptive equipment name.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces requiring insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. Locate pipe markers with arrows and color bands as follows wherever piping exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), and exterior non-concealed locations.
   1. Near each valve and control device.
   2. Near locations where pipes pass through walls or floors, ceilings or enter non-accessible enclosures.
   3. At access doors, manholes, and similar access points permitting view of concealed piping.
   4. Near major equipment items and other points of origination and termination.
   5. Spaced intermediately at maximum spacing of 30 ft along each piping run, except reduce spacing to 20 ft in congested areas of piping and equipment.
   6. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

B. Locate color bands at each marker and at intermediate spacing not to exceed 10 ft between bands, and at lesser spacing as indicated or as required by local codes.

C. Locate directional arrows at each marker. Provide 2 arrows at each tee or branch fitting.

D. Where piping is normally visible from more than 1 side, provide 2 or 3 labels and arrows spaced at 120 degree intervals around pipe in accordance with ASME A13.1.

E. Painting or Coating:
   1. Painting of piping, ductwork, and equipment is work of Section 09 9600.
   2. For piping scheduled to be color-coded, but not scheduled for complete painting (such as some plastic piping or aluminum jacked insulation) provide additional banding to represent background color. At each banding location provide following sequence:
      a. 8 in. wide tape of scheduled pipe color.
      b. 4 in. wide tape of scheduled band color.
      c. 8 in. wide tape of scheduled pipe color.

3.3 UNDERGROUND PIPING IDENTIFICATION

A. During backfilling/top soil placement of each exterior underground piping systems, install continuous underground type plastic line marker located directly over buried line at 6 to 8 in. below finished grade. Where multiple small lines buried in common trench and do not exceed overall width of 16 in., install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 MECHANICAL EQUIPMENT IDENTIFICATION

A. Install engraved plastic equipment marker on or near each major item of mechanical equipment and each operational device, if not otherwise specified for each item or device. Provide signs for each unit having equipment tag number on Drawings or in Specifications.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device visually blocked.

B. Cleaning: Clean face of identification devices and glass frames of valve schedules.

3.6 FIELD QUALITY ASSURANCE

A. Final Survey and Repairs:
   1. 1 yr after date of substantial completion, CONTRACTOR shall perform walk-through survey of mechanical identification systems and shall remove and replace any bands, labels, tags or markers that are loose, discolored, or defective.
   2. Replacement materials shall be provided by CONTRACTOR, not drawn from OWNER'S extra material.

END OF SECTION 22 0553

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SECTION 22 0810

TESTING PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hydrostatic pressure testing.
   2. Low pressure air testing.
   3. High pressure air testing.

B. Other sections identify new piping systems to be tested, identify type of test to be performed, specify test pressure, and reference this section for detailed testing requirements.

1.2 SUBMITTALS

A. Test report for each piping system tested.

B. Submit in accordance with Section 01 3300.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

A. Pressure test in presence of ENGINEER.

B. Furnish water required for testing and provide necessary piping connections between section of piping being tested and nearest available source of water or air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to perform specified tests.

C. Provide bulkheads, flanges, valves, bracing, blocking or other temporary sectionalizing devices that may be required.

D. Remove temporary sectionalizing device after tests complete.

E. Perform tests on exposed piping after piping completely installed, including supports, hangers, and anchors.

F. Perform tests on piping before insulation installed.

G. Perform tests on piping that is clean and free of dirt, sand or other foreign material.

H. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts.

I. Add test fluid slowly.

J. Include regulator set to avoid over-pressurizing and damaging piping.

K. Perform pressure testing in accordance with local, state, and federal requirements.

L. Cost of testing including water, personnel, equipment, and materials shall be CONTRACTOR'S responsibility.

M. Correct leaks or defects and retest at no additional cost to OWNER.

3.2 HYDROSTATIC PRESSURE TESTING

A. Perform hydrostatic pressure testing for piping systems identified in other sections to be hydrostatically pressure tested. Test pressure shall be as specified in other sections.

B. Open vents at high points to purge air pockets while piping system is filling. Venting may also be provided by loosening flanges or with equipment vents.

C. Testing:
1. After section of piping to be tested has been filled with water, apply test pressure by means of force pump of such design and capacity that required pressure can be applied and maintained without interruption for duration of test.
2. Measure test pressure by means of tested and properly calibrated pressure gauge acceptable to ENGINEER.
3. Maintain test pressure for sufficient length of time to permit ENGINEER to observe piping under test but not less than 2 hrs.
4. If repairs required, repeat pressure test until pipe installation conforms to specified requirements and is acceptable to ENGINEER.

D. With exception of buried piping with mechanical joints or push-on joints, piping systems shall show no visual evidence of weeping or leaking.

E. Maximum allowable leakage for buried piping with mechanical joints or push-on joints is as follows.

$$L = \frac{NDP^{1/2}}{7{,}400}$$

Where:
L = Leakage, gallons per hr
N = Number of joints under test
D = Nominal diameter of piping, in.
P = Average pressure during test, lbs per sq in.

3.3 LOW PRESSURE AIR TESTING

A. General:
1. Perform low pressure air testing for gravity sewer and drainage piping systems identified in other sections to be low pressure air tested.
2. Air Test Procedure: Test pipes between adjacent manholes. Test time for air pressure to drop 1 psig.

a. For pipes 4 in. through 24 in.: Comply with Table 1.
b. Pipe diameters above 36 in. will not be accepted by means of low pressure air test. In all cases, ignore length of laterals.

TABLE 1
LOW PRESSURE AIR TEST TIME

Specification time (min:sec) required for loss of air pressure From 3.5 psig to 2.5 psig for size and length of pipe indicated.

A	B	C	D	E	F
Pipe Dia (in.)	**Time/Ft up to Length in Column C (sec)**	**Test Length (ft)**	**Test Time for Length Between Columns C & E (min:sec)**	**Length Time in Column F Applies (ft)**	**Time/Ft for Total Length (sec)**
4	0.18	636	1:54	1,432	0.08
6	0.40	424	2:50	955	0.18
8	0.71	318	3:47	716	0.32
10	1.11	255	4:43	573	0.49
12	1.60	212	5:40	477	0.71
15	2.50	170	7:05	382	1.11
18	3.62	141	8:30	318	1.61
21	4.92	121	9:55	273	2.19
24	6.42	106	11:20	239	2.85
27	8.14	94	12:45	212	3.62
30	10.00	85	14:10	191	4.44
33	12.14	77	15:35	174	5.40
36	14.37	71	17:00	159	6.39

B. Preparation:
1. Isolate pipe section to be tested by plugging each end with air tight plugs. Plug ends of branches, laterals and wyes which are to be included in test section.
2. Brace plugs to prevent slippage and blowout due to internal pressure.
3. One plug shall have inlet tap or other provision for connecting supply air hose.
4. Connect one end of air hose to plug used for air inlet; other end to portable air control equipment.
5. Air control equipment shall consist of valves and pressure gauges to control rate at which air flows into test section and gauges to monitor air pressure inside pipe.
6. Connect air hose between source of compressed air and control equipment.

C. Testing:
1. If pipe to be tested is submerged in groundwater, determine height of groundwater above spring line of pipe at each end of test section and compute average. For every foot of groundwater above pipe's spring line, increase gauge test pressures by 0.43 lbs/sq in.
2. Add air slowly to test section until pressure inside pipe is raised to 4.0 psig greater than average back pressure of groundwater that may be over pipe.
3. After pressure of 4.0 psig obtained, control supply of air so internal pressure maintained between 3.5 and 4.0 psig (above average groundwater back pressure) for minimum of 2 min to allow temperature of air to come into equilibrium with temperature of pipe walls.
4. Determine rate of air lost by time pressure drop method.
   a. After temperature stabilized for 2-min period, disconnect air supply. Allow pressure to decrease to 3.6 psig. At this pressure, start stopwatch to determine time required

for pressure to drop 1 psig. Time required for loss of 1.0 psig is then compared to Table 1. If time is equal or greater than times indicated in table, test shall be acceptable.

3.4 HIGH PRESSURE AIR TESTING

A. Perform high pressure air testing for piping systems as specified in other sections. Test pressure shall be as specified in other sections.

B. Perform preliminary test at not greater than 25 psig. Examine for leakage at joints with soap solution and visual detection of soap bubbles. Correct visible leaks.

C. Perform final test at test pressure. Pressure in system shall be gradually increased and in small increments until test pressure reached. Test pressure shall be maintained for minimum of 10 min and additional time necessary to conduct soap bubble examination of each joint for leakage.

D. Piping system shall show no evidence of leakage.

3.5 TEST REPORT

A. Prepare and submit test report for each piping system tested. Include following information in test report.
   1. Date of test.
   2. Description and identification of piping system tested.
   3. Type of test performed.
   4. Test fluid.
   5. Test pressure.
   6. Type and location of leaks detected.
   7. Corrective action taken to repair leaks.
   8. Results of retesting.

END OF SECTION 22 0810

SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of testing, adjusting, and balancing (TAB) work required by this section indicated on Drawings, schedules, and by requirements of this section. Defined to include, but not necessarily limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of mechanical work. Work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to Work as required by Contract Documents.

B. Section Includes:
   1. Fans.
   2. Ductwork systems.
   3. Circulating Pumps.
   4. Water Source Heat Pumps.
   5. Coils and other Hydronic Equipment.

C. Equipment sections describe installation and startup of equipment to be tested, adjusted, and balanced.

D. Piping system sections describe pressure testing of piping and ductwork systems.

1.2 SUBMITTALS

A. Tests:
   1. Submit certified test reports signed by test and balance supervisor performing TAB work.
   2. Include identification and types of instruments used and most recent calibration date with submission of final test report.
   3. Submit biographical data on ENGINEER directly supervising testing, adjusting, and balancing work.

B. Shop Drawings:
   1. Submit sample test data forms complete with certifying agency logo, identifying required test data, date, page number, system designation, system location, Project name, and balancer's name.

C. Operation and Maintenance (O&M) Data:
   1. Include copies of certified test reports, identification of instruments, and data on ENGINEER.

D. Submit in accordance with Section 01 3300.

1.3 QUALITY ASSURANCE

A. Tester's Qualifications: Firm certified by NEBB in testing and balancing disciplines similar to those required for Project, not installer of system to be tested, and otherwise independent of Project.

B. Regulatory Requirements:
   1. NEBB Compliance: Comply with NEBB'S Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, as applicable to mechanical air and hydronic distribution systems and associated equipment and apparatus.

C. Industry Standards: Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing except as otherwise indicated.

1.4 PROJECT/SITE CONDITIONS

A. Do not proceed with testing, adjusting, and balancing work until system complete and operable. Ensure no later residual work still to be completed.

B. Do not proceed until Work scheduled for testing, adjusting, and balancing clean and free from debris, dirt, and discarded building materials.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. Except as otherwise indicated, use same products as used in original construction for patching holes in insulation, ductwork, and housings cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
   1. At tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2.2 TEST INSTRUMENTS

A. Utilize test instruments and equipment for TAB work required of type, precision, and capacity as recommended in following TAB standards.
   1. NEBB'S Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine installed Work and conditions under which testing to be done to ensure Work complete, clean, and operable. Do not proceed with TAB work until unsatisfactory conditions corrected in manner acceptable to tester.

3.2 ADJUSTMENT

A. Test, adjust, and balance environmental systems and components as indicated, in accordance with procedures outlined in applicable standards.
   1. Adjust flows to within -0% to +10% of scheduled values, or as otherwise instructed by ENGINEER.

B. Test, adjust, and balance system during summer season for air conditioning systems and during winter season for heating systems, including minimum period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition, and within 10°F dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation permits.

C. Patch holes in insulation, ductwork, and housings cut or drilled for test purposes in same manner as original construction.

D. Mark equipment settings including damper control positions, valve indicators, fan speed control levers, and similar controls and devices to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.

E. Retest, adjust, and balance systems subsequent to significant system modifications and resubmit test results.
   1. Provide services of qualified testing and balancing technician for random checking of systems by ENGINEER. If, during spot checking by ENGINEER, performance less than 10% of installation falls outside of specified performance parameters, rebalance entire installation.

3.3 REPORT PREPARATION

A. Prepare report of test results including instrumentation calibration reports, in format recommended by applicable standards.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced including, where necessary, modifications exceeding requirements of Contract Documents for mechanical work.

END OF SECTION 23 0593

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SECTION 23 0700

HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductwork System Insulation:
      a. Cold ductwork.
      b. Dual temperature ductwork.
   2. HVAC Piping:
      a. Condensate drain piping.
      b. Geothermal/ Raw water piping associated with WSHP's.

1.2 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

UNIT TYPE	SUBMITTAL INFORMATION ITEM
Ductwork System Insulation	1
HVAC Piping Insulation	1

B. Submittal Information:
   1. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each mechanical system requiring insulation.

C. Submit in accordance with Section 01 3300.

D. Information submitted by CONTRACTOR, but not designated to be submitted will be returned without actions by ENGINEER.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of mechanical insulation products of types and sizes required whose products have been in satisfactory use in similar service for not less than 3 yrs.

B. Installer: Firm with at least 5 yrs successful installation experience on projects with mechanical insulations similar to that required for Project.

C. Flame-Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame spread rating of 25 or less, and smoke developed rating of 50 or less, tested in accordance with ASTM E84.

D. Requirements of Regulatory Agencies:
   1. Ohio Mechanical Code (2017).
   2. International Energy Conservation Code (2012).

3. ASHRAE 90.1 (2010).

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed, showing fire hazard ratings of products.

B. Protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged insulation; remove from Project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer's equipment used as basis of design for Project is name indicated in Specifications for particular type of equipment or application contained in these Contract Documents. If no manufacturer listed, basis of design is industry standard indicated.

2.2 GENERAL

A. Provide materials and products complying with NFPA No. 90A and meeting requirements for flames spread of less than 25, smoke developed rating of less than 50, and fuel contributed of less than 50 when tested in accordance with ASTM E84.

2.3 FIBERGLASS INSULATION MATERIALS

A. Manufacturers:
1. Certainteed Corporation.
2. Schuller International, Inc.
3. Knauf Fiberglass Corporation.
4. Owens-Corning Fiberglass Corporation.
5. Or equal.

B. FGP-1, Fiberglass Insulation: ASTM C547, high temperature, preformed, fibrous glass with jacket type specified, Schedule 1 minimum thickness, and class for service temperatures indicated.
1. Piping:
a. Class 1: To 450°F, maximum k = 0.27 Btu in./hr sq ft F at 100°F.
b. Class 2: To 650°F, maximum k = 0.33 Btu in./hr sq ft F at 100°F.
c. Class 3: To 1,200°F, maximum k = 0.36 Btu in./hr sq ft F at 100°F.
2. Fittings:
a. Fiberglass Pipe Fitting Insulation: with matching premoulded PVC fittings.

C. Rigid Fiberglass Ductwork Insulation: ASTM C612, high temperature, rigid fibrous glass board with Schedule 2 jacket type and minimum thickness, and class for service temperatures indicated.
1. FGD-1 (Non-load Bearing): ASTM C612, Class 1; ASTM C547, ASTM C553, ASTM C592, and ASTM C612, Form A, Class 1, average density 1.5 pcf, maximum k = 0.24 Btu in./hr sq ft °F, to 400°F.
2. FGD-2 (Load Bearing): ASTM C612, Class 2; ASTM C547, ASTM C553, ASTM C592, and ASTM C612, Form A, Class 2, average density 3.0 pcf, maximum k = 0.23 Btu in./hr sq ft °F, to 400°F.

2.4 FLEXIBLE UNICELLULAR INSULATION MATERIALS

A. Manufacturers:
   1. Armstrong World Industries, Inc.
   2. Halstead Industrial Products.
   3. Schuller International, Inc.
   4. Rubatex Corporation.
   5. Or equal.

B. UP-1, Flexible Unicellular Pipe Insulation: ASTM C534, Type I, density 4.5 to 8.5 pcf, maximum ASTM E96 permeability = 0.3 perm in., maximum k = 0.30 Btu in./hr sq ft °F at 75°F, to 200°F.

C. US-1, Flexible Unicellular Sheet Insulation: ASTM C534, Type II, density 4.5 to 8.5 pcf, maximum ASTM E96/E96M permeability = 0.3 perm in., maximum k = 0.30 Btu in./hr sq ft °F at 75°F, to 200°F.

2.5 VAPOR BARRIER AND JACKETING MATERIALS

A. JK-1, Kraft Paper Faced Vapor Barrier Material: FS HH-B-100B, Type I, all service type aluminum foil and fiberglass yarn reinforced kraft paper. Manville Type AP, or equal.
   1. Maximum water vapor permeability, ASTM E96/E96M, 0.02 perms.
   2. Minimum tensile strength, ASTM D828, 40 lbs/in. width.
   3. Minimum Mullen burst pressure, ASTM D774/D774M, 70 psi.

B. JK-2, Kraft Paper Faced Vapor Barrier Material: ASTM C 1136, Type I, all service type aluminum foil and fiberglass yarn reinforced kraft paper with pressure sensitive closure system. Manville Type AP-T, or equal.
   1. Maximum water vapor permeability, ASTM E96/E96M, 0.02 perms.
   2. Minimum tensile strength, ASTM D828, 40 lbs./in. width.
   3. Minimum Mullen burst pressure, ASTM D774/D774M, 70 psi.

C. JA-1, Aluminum Foil Faced Vapor Barrier Material: ASTM C 1136, Type II, all service type aluminum foil and fiberglass yarn reinforced kraft paper. Manville Type FSK, or equal.
   1. Maximum water vapor permeability, ASTM E96/E96M, 0.02 perms.
   2. Minimum tensile strength, ASTM D828, 40 lbs./in. width.
   3. Minimum Mullen burst pressure, ASTM D774/D774M, 70 psi.

D. Weatherproof Rigid Metal Jacket Materials:
   1. JRA, 0.016 in. aluminum, with Pittsburg seam, butt joint strips, matching fitting covers, and weatherproof mastic.

2.6 INSULATION ACCESSORIES

A. Ductwork Insulation Accessories: Provide staples, wires, bands, wire netting, stud pins, and metal cover tape, anchors, corner angles, and similar accessories as recommended by insulation manufacturer for application indicated.

B. Insulating Compounds: Provide fire retardant, moisture resistant, mildew resistant, and verminproof cements, mastics, sealers, protective finishes, and similar compounds as recommended by insulation manufacturer for applications intended.
   1. Insulation Bonding and Lap Adhesives: Benjamin Foster No. 85-20, or equal.

2. Vapor Barrier Coatings: Benjamin Foster No. 30-35, or equal.
3. Lagging Adhesives: Benjamin Foster No. 30-36, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's written instructions and recognized industry practices to ensure insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Butt insulation joints together to ensure complete and wrinkle-free fit over surfaces to be covered. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Where multiple layers required, apply each layer of insulation separately.

C. Maintain integrity of vapor barrier of insulation and protect to prevent puncture and other damage.

D. Extend insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated.

E. Install insulation on systems and equipment subsequent to testing and acceptance tests. Do not apply insulation to hot surfaces.

F. Insulate each continuous run of piping with full length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

G. Cover insulated equipment surfaces with glass cloth jacketing wrinkle-free and positively secured. Lap seams at least 2 in. Apply over vapor barrier where applicable. Do not insulate boiler manholes, handholes, cleanouts, ASME stamps or manufacturer's nameplates. Provide beveled edge at interruptions of insulation.

H. Trowel insulated surfaces with layer of insulating cement, leaving smooth continuous surface. Fill in scored block, seams, chipped edges, and depressions and cover over wire netting and joints with cement.

I. Cover valves, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated fittings, at installer's option, except where specific form or type indicated.

J. Provide removable insulation sections to cover parts of equipment which will be opened periodically for maintenance. Include metal vessel covers, fasteners, flanges, frames, and accessories.

K. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

L. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.

M. Pipe Hanger Insulation Inserts: Butt pipe insulation against pipe hanger insulation inserts. For hot piping, apply 3 in. wide vapor barrier tape or band over butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 in. wide vapor barrier tape or band.

N. Insulation Exposed to Weather: Protect from weather by installing Type JRA jacketing.

3.2 HVAC PIPING SYSTEM INSULATION

A. Insulation Omitted: Do not provide insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.

B. Cold Piping (40°F to 65°F):
   1. Application Requirements:
      a. Geothermal/ raw water piping systems associated with WSHP's.
      b. Condensate drain piping.
   2. Insulate each piping system specified above with 1 of following types and thicknesses in accordance with Schedule 1.
      a. Insulation: Fiberglass (FGP-1) with Type JK-2 jacket.
      b. Flexible Unicellular Insulation (UP-1), condensate drain piping only.

C. Insulation of Piping Exposed to Weather: Protect outdoor piping insulation from weather by installing Type JRA jacketing.

D. Insulation Thickness: Schedule 1.
   1. Thicknesses specified are minimums based on insulation having thermal resistance in range of 4.0°F sq ft hr/Btu in. to 4.6°F sq ft hr/Btu in. of thickness on flat surface at mean temperature of 75°F. In accordance with Schedule 1.
      a. For piping exposed to outdoor ambient temperatures, increase thickness by 1/2 in.
      b. Runouts not exceeding 12 ft in length to individual terminal units.

3.3 DUCTWORK AND EQUIPMENT INSULATION

A. Insulate ductwork and equipment in accordance with Schedule 2.

3.4 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Protect insulation work during remainder of construction period to avoid damage and deterioration.

SCHEDULE 1 TO SECTION 23 0700 Insulation Thicknesses in In. for Pipe Sizes			
Piping System Types	**Fluid Temp. Range °F.**	**1-1/2 in. and Less**	**2 in. and Larger**
Geothermal/ Raw Water Supply & Return Piping	40-65	1-1/2	1-1/2
Condensate Drain Piping	Any	3/4	1

SCHEDULE 2 TO SECTION 23 0700 Ductwork and Equipment Insulation Thickness (in.)			
Item	**Insulation Type**	**Jacket Type**	**Insulation Thickness**
Outside Air Ductwork (Up to damper)	FGD-1	JK-1 / JA-1	1-1/2
	FGD-2	JK-1 / JA-1	1-1/2
	US-1	JK-1 /JA-1	1-1/2
Supply and Return Air Ductwork (Concealed, located above acoustical ceiling tile)	FGD-1	JK-1/ JA-1	1-1/2
	FGD-2	JK-1/JA-1	1-1/2

END OF SECTION 23 0700

SECTION 23 0933

AUTOMATIC TEMPERATURE CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Control sequences are specified in Section 23 0993.

B. Provide following electrical work as Work of this section, complying with requirements of Division 26.
   1. Control and power wiring, of all voltages, between field-installed control elements, indicating devices, and unit control panels.

C. Products furnished but not installed under this section:
   1. Refer to following sections for damper installation requirements:
      a. Air Distribution Systems: Section 23 3010.

D. Work by Electrical:
   1. Power supply wiring for HVAC Equipment and Automatic Temperature Control Panels.

1.2 DEFINITIONS

A. Point Chart:
   1. System Description: Particular system to which following points apply.
   2. Point Type:
      a. Supervised Binary: Point type having 2 conditions or values and no intermediate units. Change of state initiates alarm or advisory sequence and requires acknowledgment of alarm condition and initiates alarm or advisory sequence. Provide software definable advisory sequence.
      b. Binary: Point type having 2 conditions or values and no intermediate values.
      c. Analog: Point type having continuous range of values. Accomplish analog sensing by RTD sensing elements located directly in medium to be measured. Locate temperature sensors within wells when measuring liquid temperatures.
      d. Start/Stop: Point type changing binary state of controlled variable.
      e. Adjust: Point type changing analog condition of controlled variable.

B. Analog Indication: Type of readout provided for analog points accessed by operator.

C. Binary Indication: Type of readout provided for binary points accessed by operator or alarming condition.

D. Applications/Programs: Building automation system/direct digital control processes to be applied to system or point identified under point type.

1.3 SUBMITTALS

A. Product Data:

1. Submit manufacturer's technical product data for each control device furnished indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and installation and startup instructions.
2. Motors: For poly-phase motors 5 hp and larger, submit in accordance with requirements of Section 26 2000. For single-phase, definite purpose, special purpose and general purpose poly-phase motors less than 5 hp, submit NEMA design types, construction, insulation class, NEMA frame size, horsepower, voltage and amp draw characteristics, and service factor for each common application.

B. Shop Drawings: Submit ladder type wiring diagram for each control device, general control system diagrams, and connections provided by others.
1. Represent each system with schematic flow diagram showing each active system component in relative position and other devices present, but not necessarily affected by control system. Show field-mounted control devices.
2. Represent panel mounted control components within designated panel section of Drawings. Provide one-line detailed schematic of wiring and piping.
3. Provide one-line schematic for starters affected by control system showing interlocks between starters and control system and other interlocks not necessarily provided as part of control system.
4. Label each control device with setting or adjustable range of control.
5. Indicate required electrical wiring. Differentiate between portions of wiring factory-installed and portions field-installed.
6. Details of faces of control panels including controls, instruments, and labeling.
7. Written description of sequence of operation.
8. Dampers: Submit leakage and flow characteristics of dampers, and size schedule for controlled dampers.

C. Miscellaneous:
1. Maintenance agreement.

D. Operating and Maintenance (O&M) Data:
1. Submit preventive maintenance data and spare parts list for each type of control device; detailed instructions for operations associated with man-machine interface; and operator's reference table listing connecting input points, output points, and unguarded software parameters. Include this data in maintenance manual.
   a. Include Shop Drawings of control system, revised to reflect system in as-built condition.
2. Programmer’s Manual: Submit programming data for necessary information to perform programming function; language manual describing language used and routines, modules, used by system; program flow charts for system energy management software and custom software; and complete program listing and parameter listing files for programs.

E. Submit in accordance with Section 01 3300.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of electrical and direct digital control equipment of type, architecture, and sizes similar to required equipment, and in satisfactory service.

B. Installer's Qualifications: Firms specializing and experienced in electrical and direct digital control system installations.

C. Regulatory Requirements:
   1. Provide electrical products tested, listed, and labeled by UL and complying with NEMA standards for electrical requirements of areas in which controls are installed.
   2. Refer to Drawings for specific area classifications impacting control system design.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship each piece of equipment and control device in factory cartons. Provide factory-applied plastic end caps on each length of pipe and tube.

B. Maintain cartons and end caps through shipping, storage, and handling as required to prevent equipment and pipe end damage and eliminate dirt and moisture from equipment and inside of pipe and tube.

C. Store equipment indoors in clean, dry area until ready for installation.

1.6 MAINTENANCE

A. Within 30 days after Substantial Completion, present to OWNER for consideration, preventive maintenance contract to cover service incidental to continued proper performance of system and devices during guarantee period.

B. Maintenance of system components are not CONTRACTOR'S responsibility during and after guarantee period, unless contracted for by OWNER.

C. Provide schedule of maintenance tasks necessary to keep CONTRACTOR guarantee in effect through guarantee period.

D. Provide list of recommended preventive maintenance procedures including task frequency and tools required to perform tasks. Provide instructions for each task in O&M data.

E. OWNER will keep records, schedules, and other reports documenting OWNER-performed prescribed maintenance procedures during guarantee period. CONTRACTOR not liable for defective systems, devices or components or repair, if OWNER-performed required preventive maintenance procedures not performed and documented.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer's equipment used as basis of design for Project is name indicated in Specifications for particular types of equipment or application. If no manufacturer listed, basis of design is industry standard indicated.

B. Manufacturers:
   1. Automated Logic Controls.
   2. Johnson Controls.
   3. Honeywell.

4. Siemens.
5. Trane.
6. Or equal.

2.2 GENERAL

A. Provide automatic temperature control products and supporting system components of type, architecture, size, and capacities indicated, conforming to manufacturer's standard materials and components as published in product information; designed and constructed as recommended by manufacturer and required for application indicated to meet the intended control sequence of operations for each piece of equipment specified.

2.3 ACTUATORS

A. Electric Operators: Size motors to operate with sufficient reserve power to provide smooth modulating action or 2-position action.
   1. Provide permanent split capacitor or shaded pole type motors with gear trains completely oil immersed and sealed. Equip spring return motors, where indicated on Drawings or in operational sequence, with integral spiral spring mechanism. Furnish entire spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches or feedback potentiometer.
   2. Equip motors for outdoor locations and outside air intakes with O-ring gaskets designed to make motors completely weatherproof, and internal heaters permitting normal operation at -40°F.
   3. Furnish multiple spring return motors for dampers larger than 25 sq ft. Size spring return motors for running torque rating with minimum 3 to 1rated to required torque ratio.
   4. Furnish modulating electric operators with control circuitry designed to accept 4-20 mA, 2 to 10 vdc, or pulse width modulation input control signals, appropriate to application.

2.4 INPUT DEVICES

A. Room Thermostats:
   1. Provide solid state thermostats with user adjustable temperature setpoints, deadbands, and offsets.
   2. Thermostat shall include capabilities for use of local and remote temperature sensors.
   3. Thermostat shall incorporate a time clock function with user defined occupied and unoccupied periods and corresponding heating and cooling setpoints.
   4. Thermostat shall include a user accessible, timed unoccupied override function.
   5. Thermostat shall include a local display of space temperature, mode of operation, active temperature setpoints, and simple alarms.
   6. Thermostat shall incorporate battery backup and password protected lockable keypad.
   7. Thermostat shall incorporate heat anticipation and system on/off selector.

B. Temperature Sensors:
   1. Provide temperature sensing elements of nickel wire, electric resistance type for space, well, or duct insertion application.
   2. Elements shall have reference resistance of 1,000 ohms/°F, with reference resistance of 1,000 ohms at 70°F, with temperature coefficient of 3 ohms/°F.
   3. Resistance tolerances shall be 1.0% at 70°F.
   4. Minimum ambient temperature range shall be -40°F to 216°F.

2.5 OUTPUT DEVICES

A. Relays and Contactors:
   1. UL listed units rated for 100,000 cycles with resistive loads. Equip with replaceable molded coils and replaceable silver cadmium oxide contacts. Coat core laminations with heat resistant inorganic film to reduce core losses.
   2. For line and load terminals on contactors with higher than 35 amp rating, provide 1-piece formed and welded pressure type.
   3. For 35 amp or lower rating, provide screw type contactors.
   4. Equip field-mounted contactors with suitable steel enclosures.

2.6 CONTROLLERS

A. Electronic Controllers:
   1. Provide electronic controllers designed as individual components and fully protected by steel enclosures.
   2. Provide individual controllers of multiple input type with provisions for user adjustment.
   3. Identify adjustments clearly on controllers including proportional band and authority.
   4. Where single electronic controller required for specific application, can be built-in as integral part of control motor, but only where provided with easily accessible control adjustment.
   5. Provide 2-position or proportional electric controller power output as required by specified sequence of operations.

B. Step Controllers:
   1. Provide step controllers for control sequencing or control of staged outputs with heavy duty switching rated to handle loads.

2.7 PANELS

A. Local Control Panels/Temperature Control Panels (TCP): Provide control panels with suitable brackets for wall or floor mounting for each supply fan and miscellaneous control systems. Locate panel adjacent to systems served.
   1. Fabricate panels of 14 ga furniture quality steel or 6063-T5 extruded aluminum alloy, totally enclosed with hinged doors and keyed lock, NEMA-4X rating, with manufacturer's standard shop painted finish and color. Provide UL listed and certified cabinets for use with line voltage devices.
   2. Panel-Equipment: Include temperature and humidity controllers, relays, and automatic switches except exclude low temperature protection thermostats, firestats, and other devices excluded in sequence of operation. Fasten devices with adjustments accessible through front of panels.
   3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches including damper Minimum-Off positioning switches, Summer-Winter switches, and Manual-Automatic switches, including dial thermometers.
   4. Graphics: Where specified, provide color coded graphic laminated plastic displays on doors to schematically show system being controlled. Provide protective sheet of clear plastic bonded to entire door to prevent damage to symbols.
   5. Temperature control panels shall contain all the necessary control components and control wiring to meet the functional HVAC control descriptions specified in Section 23 0993.

B. Central (Master) Control Panels: Provide central control panels of fully enclosed steel cubical type with locking doors or locking removable backs. Match finish of panels and provide multi-color graphic displays schematically showing system being controlled.

2.8 VALVES

A. Control Valves:
   1. General:
      a. Provide factory-fabricated, electrically actuated control valves of type, body material, and pressure class required.
      b. Where type or body material not indicated, provide selection as determined by manufacturer for installation requirements and pressure class based on maximum pressure and temperature in piping system.
      c. Equip control valves with heavy duty actuators and proper shut-off rating for each individual application.
   2. Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1.
   3. Single Sealed Valves: Cage type trim providing seating and guiding surfaces for plug on top and bottom guided plugs.
   4. Double Seated Valves: Balanced plug type with cage type trim providing sealing and guiding surfaces on top and bottom guided plugs.
   5. Valve Trim and Stems: All sizes, polished stainless steel.
   6. Packing: Spring loaded Teflon, self-adjusting.
   7. Valve Pressure Drop: Size valves for following.
      a. 3-Way Valves: Valve pressure drop shall equal or exceed pressure drop of terminal devices served. Pressure drops of valves in secondary piping bridge circuits shall not exceed 5 ft of water column.
      b. 2-Way Valves: Valve pressure drop shall not exceed 5 ft of water column.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which electric control systems to be installed. Do not proceed with Work until unsatisfactory conditions corrected.

3.2 INSTALLATION

A. Install system and materials in accordance with manufacturer's instructions, roughing-in drawings, details on Drawings, and approved submittals. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these Specifications. Mount controllers at convenient locations and heights.

B. Installation of Mechanical Devices: Refer to other Division 23 sections for installation of valve bodies, control sensor wells, and dampers.

3.3 EQUIPMENT AND WIRING

A. Control Wiring: Install and color code control wiring without splices between terminal points. Install in accordance with NFPA No. 70 and applicable sections of Division 26. Install wiring incidental to system installation.
   1. Install circuits over 25 v with color coded minimum No. 12 wire in electric metallic tubing.

2. Install circuits under 25 v with color coded minimum No. 18 wire with 0.031 in. high temperature (105°F) plastic insulation on each conductor and plastic sheath over all.
3. Install electronic circuits with color coded minimum No. 22 wire with 0.023 in polyethylene insulation on each conductor with plastic jacketed copper shield over all.
4. Install low voltage circuits, located in concrete slabs and masonry walls or exposed in occupied areas, in electric conduit.
5. Do not install digital bus wiring in same conduit with line voltage wiring or other conductors with highly inductive loads.
6. Enclose line voltage wiring in rigid galvanized steel conduit. Enclose low voltage wiring in plastic/AMT conduit.

B. Installation of Damper Operator Motor: Power damper motor from line voltage power or from dedicated transformer. Do not power damper motor from MCC motor starter control transformer.

C. Installation of Relay and Starters: Where relays or motor starters are required to control single phase motors, damper operators and other loads, mount relays or starters in temperature control panels or dedicated electrical cabinets in accordance with UL 50 and Sections 26 0505 and 26 0900.

3.4 FINAL ADJUSTMENT OF EQUIPMENT

A. After completion of installation, adjust thermostats, control valves, motors, and similar equipment provided under this section.

B. Verify programming for proper control action and adjust operating setpoints to achieve optimum system operation.

C. Include computer programming, record drawings, labor for adjusting and validating, and checkout necessary for operational system.

D. Provide specially trained personnel for final adjustment Work.

E. Startup, test, and adjust control systems. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:
1. Supplier’s or manufacturer’s representative for equipment specified herein shall be present at jobsite or classroom designated by OWNER for mandays indicated, travel time excluded, for assistance during construction, startup, and training of OWNER’S personnel for equipment operation. Include:
   a. 1/2 manday for Instructional Services.

B. Operator Instruction:
1. Provide hands-on operator instruction to OWNER’S operating personnel during system commissioning and at such time acceptable performance of DDC hardware and software established. Provide instruction during normal working hours by CONTRACTOR’S representative familiar with system software, hardware, and accessories. Demonstrate compliance meeting the intended control sequence of operations for all equipment specified.

2. At mutually agreed upon time during system commissioning, provide instruction to OWNER'S designated personnel on operation of equipment within electric control and DDC system and describe intended use with respect to programmed functions specified.
3. Include overall operational program, equipment functions (individually and as part of total integrated system), commands, advisories, and appropriate operator intervention required in responding to system operation. Include in O&M data.

3.6 CLEANING

A. Clean factory finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 0933

SECTION 23 0993

AUTOMATIC CONTROL SEQUENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Operating equipment, devices, and system components required for automatic temperature control systems which are specified herein**.**

1.2 DEFINITIONS

A. Control Sequences: Manner and method by which automatic temperature controls function. Requirements for each type of operation are described in this section.

B. Normal Mode: Mode or position-controlled device assumes without power.

C. Automatic Mode: Mode or position-controlled device assumes when under control of automatic system of controls.

D. Manual Mode: Mode or position-controlled device assumes when under manual control. Unless otherwise specified, manual mode implied and affects only device for which manual mode or position identified.

1.3 SUBMITTALS

A. Shop Drawings:
1. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and control devices.
2. Label each control device with setting or adjustable range of control.
3. Indicate pneumatic piping, factory and field wiring.
4. Indicate each control panel required with internal and external piping and wiring clearly indicated. Provide detail of panel face including controls, instruments, and labeling.
5. Include written description of sequence of operation.

B. Submit in accordance with Section 01 3300.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 VARIABLE SPEED EXHAUST EQUIPMENT (CONTINUOUS VENTILATION)

A. Control Sequence - Exhaust Fan:
1. Units Served:
a. EF-1: Interlocked with CD-1 and CD-5. (TCP-1)
b. EF-2: Interlocked with CD-2 and CD-6. (TCP-1)
c. EF-3: Interlocked with CD-3 and CD-7. (TCP-1)
d. EF-4: Interlocked with CD-4 and CD-8. (TCP-1)

e. EF-7: Interlocked with CD-10 and CD-11. (TCP-3)

2. Normal Mode: Off.
   a. Fan: Off.
   b. Outside Air Damper: Closed.
   c. Exhaust Air Damper: Closed.
3. On Mode:
   a. Provide maintain type fan START, non-powered, contact closure(s) for VFD motor start inputs provided and installed by Division 23. Provide 4-20 mAdc analog signals to VFD for fan speed control and accept 4-20 mAdc signals for speed indication at TCP.
   b. VFDs provided and installed by Division 23. Mount VFD's on exterior wall near TCP and fans.
   c. Manually start and stop fans through Hand/Off switch located at TCP. In the hand position, open outside air and exhaust air dampers, send fan Start Signal to VFD and start exhaust fan, adjust fan speed and outside air damper position automatically based on outside air temperature:
      1) When outside air temperature is below 45°F (field adjustable), match minimum air-flows shown on drawings.
      2) When outside air temperature is above 45°F (field adjustable), match maximum air-flows shown on drawings.
   d. Fan Status: Provide illuminated (Green LED) pilot light mounted at TCP to indicate fan energized. Monitor fan status through differential pressure switch and illuminated warning (Red LED) pilot light mounted at TCP. Provide local alarm condition when fan motor starter engaged and air-flow not present.

3.2 DEPENDENTLY CONTROLLED EXHAUST EQUIPMENT (CONSTANT SPEED)

A. Control Sequence - Exhaust Fan:
   1. Units Served:
      a. EF-5: Interlocked with WSHP-6. (TCP-2)
      b. EF-6: Interlocked with WSHP-6. (TCP-2)
   2. Normal Mode: Off.
      a. Fan: Off.
   3. Automatic Mode:
      a. Start fan through Hand-Off-Automatic switch located at TCP.
      b. Provide maintain type fan START, non-powered contact closure(s) for motor start inputs provided by Division 26.
      c. Automatic Mode: When run signal received from WSHP, send fan Start signal to Electrical and start fan. When run signal removed, reverse procedure.
      d. Exhaust fans are provided with solid state speed controllers. Adjust fan speed manually to match scheduled air-flow.
      e. Fan Status: Provide illuminated (Green LED) pilot light mounted at TCP to indicate fan energized. Monitor fan status through differential pressure switch and illuminated warning (Red LED) pilot light mounted at TCP. Provide local alarm condition when fan motor starter engaged and air-flow not present.
   4. Hand Mode: On.
      a. In the hand position, send fan Start signal to Electrical, start fan, and run continuous. On shutdown, reverse procedure.

3.3 MANUALLY ACTUATED CEILING FANS

A. Control Sequence - Ceiling Fans:
   1. Units Served:
      a. CF-1.
      b. CF-2.
      c. CF-3.
      d. CF-4.
      e. CF-5.
      f. CF-6.
   2. Normal Mode: Off
      a. Ceiling Fans: Off.
   3. On Mode:
      a. Manually Start and Stop ceiling fans through manufacturer provided solid state speed controller. Manually adjust fan speed as desired.

3.4 ELECTRIC HEATERS

A. Control Sequence – Electric Unit Heaters:
   1. Units Served:
      a. EH-1.
      b. EH-2.
      c. EH-3.
      d. EH-4.
      e. EH-7.
      f. EH-8.
      g. EH-9.
      h. EH-10.
      i. EH-11.
      j. EH-12.
   2. Normal Mode: Off.
      a. Power: Off.
   3. Automatic Mode: On.
      a. Provide unit with complete system of factory or remote installed controls suitable for use with manufacturer furnished control power transformer and low voltage thermostat with fan-off-heat sub-base.
      b. Fan Mode: Start unit fan and operate continuously. Lockout electric heating element when fan mode engaged.
      c. Heat Mode: On call for heat from manufacturer provided thermostat, set at 55°F (field adjustable) normally open contact closes and electric heating element turns on in stages. Start fan through manufacturer provided time delay relay. On satisfaction of space heating demand, contact opens. Stop fan when all heat has been dissipated.

B. Control Sequence – Electric Wall Heaters:
   1. Units Served:
      a. EH-5.
      b. EH-6.
   2. Normal Mode: Off.
      a. Power: Off.
   3. Automatic Mode: On.
      a. Provide unit with complete system of factory-installed controls including single pole integral thermostat and bi-metallic, snap action type, fan control and thermal cutout.

b. Heat Mode: On call from heat from integral thermostat, set at 70ºF, field adjustable, activate fan after heating element reaches operating temperature, and continue to operate fan after thermostat is satisfied and until all heat has been dissipated.
c. Thermal cutout shall shut off power to heating element in the event of overheating.

3.5 DEHUMIDIFIER

A. Control Sequence - Dehumidifier (Manufacturer-Supplied Controls):
1. Unit Served:
a. D-1.
b. D-2.
c. D-3.
d. D-4.
e. D-5.
f. D-6.
2. Normal Mode: Off.
a. Fan: Off.
b. Compressor: Off.
c. Condensate Pump: Off
3. Automatic Mode: On.
a. Fan shall be controlled by "On-Auto" fan switch. With switch in "Auto" position and on call for dehumidification from humidistat, set at 50% relative humidity, field adjustable, fan and compressor shall start. When relative humidity of space is below set-point, de-energize fan and compressor.
b. With fan switch in "On" position, fan shall operate continuously while compressor cycles "On" and "Off" to satisfy relative humidity set-point.
c. Condensate pump shall cycle "On" and "Off" as required.
d. Unit shall be provided with manufacturer provided controls.

3.6 EMERGENCY SHOWER/EYEWASH MONITORING – WATER FLOW ALARM

A. Areas Served:
1. R107 Corrosion Inhibitor. (ES-1 and EEW-1)
2. R108 Sodium Hydroxide. (ES-1 and EEW-1)
3. R109 Sodium Bisulfite (ES-1 and EEW-1)
4. R110 Antiscalant (ESEW-1)
5. Outside chemical fill areas; two locations (ESEW-2)

B. Emergency Shower/ Eyewash Monitoring: Monitor emergency shower/ eyewash operation through flow switch mounted on the water supply line serving fixture provided/ installed by Division 22 and illuminated red LED warning light located at TCP-1. Provide alarm condition when flow switch is activated and send “ESEW – Chemical Room Name/Location” signal to plant’s SCADA (Division 40).

3.7 HEATING AND AIR CONDITIONING SYSTEM – WATER SOURCE HEAT PUMPS

A. Control Sequence – Water Source Heat Pumps (WSHP):
1. Units Served:
a. WSHP-1.
b. WSHP-2.
c. WSHP-3.

d. WSHP-4.
e. WSHP-5.
f. WSHP-6. Interlocked with exhaust fans (EF-5 & 6) and outside air damper (CD-9).

2. General:
   a. Each Water Source Heat Pump shall be equipped with factory installed stand-alone controls as specified in Section 23 8146.
   b. Additional HVAC controls as specified herein shall be provided within Temperature Control Panel (TCP-2).
   c. Solenoid water control valves shall fail in the fully closed position upon loss of power.
   d. Electric actuated three-way valves (diverting type) shall be open to the Water-to-Refrigerant Heat Exchanger upon loss of power. During economizer mode; WSHP to operate 3-way valve open to Water Source Economizer.
   e. The space thermostat shall be low-voltage, digital type, with room temperature readout.
   f. Provide smoke detector in return air duct and send "smoke detection" signal to building Fire Alarm panel. See Section 28 3100.
   g. Each WSHP shall be provided with a "Run Enable" signal from plant's SCADA (Division 40) that allows WSHP to operate when the plant is operational and raw water pipe has available flow/pressure.
   h. Filter Status: Indicate filter pressure drop through panel mounted differential pressure switch and illuminated (Red LED) pilot light at TCP-2. When filter pressure drop exceeds 0.50 in. w.c., indicate a "dirty filter" alarm condition.
   i. Smoke control: Provide smoke detector mounted in return air duct. Upon smoke detection shut down supply fan and send "Smoke Detection" alarm signal to building Fire Alarm panel.

3.8 PRIMARY CIRCULATING PUMPS – BUILDING RAW WATER LOOP (VARIABLE SPEED)

A. Control Sequence – Circulating Pump, CP:
   1. Units Served:
      a. CP-1: Run with VFD; Leed Pump (TCP-2).
      b. CP-2: Run with VFD; Lag Pump (TCP-2).
   2. Normal Mode: Off.
      a. Pump: Off.
   3. General:
      a. Pump run signal to be received from WSHP(s) through TCP when WSHP(s) are calling for heating/cooling.
   4. Automatic Mode: On.
      a. Pump Control: Start and stop pumps automatically through TCP, variable frequency drive, and raw water differential pressure sensor and transmitter. When TCP calls for heating/cooling, start pump at minimum operating speed, set at 35% (field adjustable), operate pump continuously and for 1-hour (field adjustable) after run signal is removed. Adjust pump speed automatically by adjusting pump's VFD frequency to maintain differential pressure set-point set at +8-ft. (field adjustable) to meet system demand.
      b. Provide maintain type pump Start, non-powered contact closure(s) for VFD motor start inputs provided by Division 23. Provide 4-20 mAdc analog signals to VFD for pump speed control and accept 4-20 mAdc signals for speed indication at TCP.
      c. VFD's provided and installed by Division 23.

d. Lead/Lag Operation: Provide Lead/Lag pump control through BAS. Operate Lead pump for duration of 48 hours (field adjustable) with Lag pump as stand-by. Alternate Lead/Lag pump assignments every 48 hours (field adjustable). If Lead pump does not satisfy heating water flow demand, allow Lag pump to operate. Monitor and record pump run time at TCP.

e. Back-pressure Flow Control Valve: Set back-pressure flow control valve to open when pressure reaches 120 ft. head (field adjustable).

END OF SECTION 23 0993

SECTION 23 2113

HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

Unit Type	Submittal Information Item
Piping	1, 2, 3
Valves	1, 4

B. Submittal information:
   1. Product Data: Submit manufacturer's technical product data and installation instructions for piping materials and products.
   2. Shop Drawings: Submit scaled layout drawings of hydronic piping systems including, but not necessarily limited to, pipe and tube sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and equipment.
   3. Record Drawings: At Project closeout, submit record drawings of installed piping and piping products in accordance with Section 01 7700.
   4. Operation and Maintenance (O&M) Data:
      a. Submit maintenance data and parts lists for hydronic piping materials and products.

C. Submit in accordance with Section 01 3300.

D. Information submitted by CONTRACTOR, but not designated to be submitted will be returned without action by ENGINEER.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hydronic piping products of types, materials, and sizes required whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Installer's Qualifications: Firm with at least 3 yrs successful installation experience on projects with hydronic piping work similar to required for Project.

C. Regulatory Requirements:
   1. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9.
   2. UMC Compliance: Fabricate and install hydronic piping in accordance with Ohio International Mechanical Code (2017).

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by CONTRACTOR complying with installation requirements.

B. Comply with ASME B31.9 where applicable; base pressure rating on hydronic piping systems maximum design pressures.

C. Provide sizes and types matching piping and equipment connections and provide fittings of materials matching pipe materials used in hydronic piping systems.

D. Where more than one type of materials or products indicated, selection CONTRACTOR'S option.

E. Insulation: Comply with Section 23 0700.

2.2 IDENTIFICATION

A. Comply with Section 22 0553 and provide following:
1. Hydronic Piping: Plastic pipe markers.
2. Hydronic Valves: Plastic valve tags.

2.3 PIPES AND PIPE FITTINGS

A. Comply with following:
1. Pipe Size 2 in. and Smaller: Galvanized steel pipe, Schedule 40, Class 125 galvanized cast iron fittings with threaded joints.
2. Tube Size 3 in. and Smaller: Copper tube, Type L, hard drawn temper, wrought copper fittings with soldered joints.
3. Pipe Size 2-1/2 in. and Larger: Galvanized steel pipe, Schedule 40, grooved joint fittings, Victualic Rigid or equal.

2.4 PIPING SPECIALTIES

A. Comply with Section 22 0010 and following:
1. Pipe escutcheons.
2. Pipe line strainers.
3. Dielectric unions.
4. Drip pans.
5. Sleeves.
6. Sleeve seals.

2.5 SUPPORTS AND ANCHORS

A. Comply with Section 22 0529 and following:
1. Adjustable steel clevises, pipe saddle supports, single pipe rolls, and roller hangers for horizontal piping hangers and supports.
2. 2-bolt riser clamps for vertical piping clamps.
3. Steel turnbuckles for hanger rod attachments.
4. Concrete inserts, C-clamps, malleable beam clamps, and steel brackets for building attachments.
5. Protection saddles for saddles and shields.

2.6 VALVES

A. Comply with following:
   1. Sectional Valves:
      a. 2 in. and Smaller: Gate valves.
      b. 2 in. and Smaller: Ball valves.
      c. 2-1/2 in. and Larger: Gate valves.
      d. 2-1/2 in. and Larger: Butterfly valves.
   2. Shutoff Valves:
      a. 2 in. and Smaller: Gate valves.
      b. 2 in. and Smaller: Ball valves.
      c. 2-1/2 in. and Larger: Gate valves.
      d. 2-1/2 in. and Larger: Butterfly valves.
   3. Heating/Cooling Terminal Outlet Valves:
      a. 2 in. and Smaller: Gate valves and calibrated balance valves.
      b. 2 in. and Smaller: Ball valves and calibrated balance valves.
      c. 2-1/2 in. and Larger: Gate valves and balance cocks with flow meters.
      d. 2-1/2 in. and Larger: Butterfly valves and balance cocks with flow meters.
   4. Drain Valves:
      a. 2 in. and Smaller: Gate valves.
      b. 2 in. and Smaller: Ball valves.
      c. 2-1/2 in. and Larger: Gate valves.
   5. Check Valves:
      a. All sizes: Swing check valves.
      b. 2 in. and Smaller: Silent check valves.
      c. 2-1/2 in. and Larger: Wafer check valves.

2.7 BACKPESSURE FLOW CONTROL VALVES

A. Manufactures:

   1. Emerson, Series 6853.
   2. Bell and Gossett ITT, Fluid Handling Division.
   3. Dunham-Bush, Inc.
   4. Taco, Inc.
   5. Or equal.

B. Rate for 125 psi, contain globe style assembly automatically opening by means of excess upstream flow pressure, and automatically maintain setpoint pressure. Provide with means to manually open in case of pump failure.

C. Threaded Ends 2 in. and Smaller: Cast iron body, bronze check mechanism, screw-in bonnet, straight or angle pattern.

D. Threaded and Flanged Ends 2-1/2 in. Through 4 in.: Cast iron body, bronze check mechanism, screw-in bonnet, straight or angle pattern.

2.8 EXPANSION COMPENSATION

A. Comply with following and industry standard:
   1. Packless expansion joints.
   2. Flexible ball pipe joints.

3. Expansion joints for grooved piping.
4. Pipe alignment guides.

2.9 METERS AND GAUGES

A. Comply with following and industry standard:
1. Temperature gauges and fittings.
2. Pressure gauges and fittings.
3. Flow measuring meters.

2.10 VIBRATION CONTROL

A. Comply with following and industry standard:
1. Isolation hangers.
2. Riser isolators.
3. Riser support isolators.
4. Flexible pipe connectors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which hydronic piping systems materials and products installed. Do not proceed with Work until unsatisfactory conditions corrected.

3.2 INSTALLATION OF BASIC IDENTIFICATION

A. Comply with Section 22 0553.

B. Apply piping labels and flow arrows on clean, dry insulated piping systems.

C. Install labels and flow arrows at equipment connections, branch fittings and at 20 ft intervals.

3.3 INSTALLATION OF HYDRONIC PIPING

A. Install eccentric reducers where pipe reduced in size in direction of flow, with tops of both pipes and reducer flush.

B. Install piping with no pitch.

C. Connect branch feed piping to mains at horizontal centerline of mains and run piping out to branches at horizontal centerline of branches.

D. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

E. Insulate system in accordance with Section 23 0700.

F. Install fire seals in each fire rated wall and floor opening applying putting or caulking in accordance to manufacturer’s instructions.

3.4 INSTALLATION OF PIPING SPECIALTIES

A. Comply with Section 40 0543.

3.5 INSTALLATION OF SUPPORTS AND ANCHORS

A. Comply with Section 22 0529.

3.6 INSTALLATION OF VALVES

A. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more hydronic terminals or equipment connections, and elsewhere as indicated.

B. Shut-Off Valves: Install on inlet and outlet of each mechanical equipment item, on inlet of each hydronic terminal, and elsewhere as indicated.

C. Hydronic Terminal Outlet Valves: Install on outlet of each hydronic terminal and elsewhere as indicated.

D. Drain Valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, each rise or drop in piping system, and elsewhere as indicated or required to completely drain hydronic piping system.

E. Check Valves: Install wafer or silent check valves on discharge side of each pump and elsewhere as indicated. Install swing check valves in horizontal piping as indicated.

F. Back Pressure Flow Control Valves: Install back pressure control valves on bypass lines to allow flow back to pumps when pressure reaches 110 to 115% of system pressure, field adjustable.

G. Install temperature control valves furnished under Section 23 0933.

3.7 EQUIPMENT CONNECTIONS

A. Connect hydronic piping system to mechanical equipment as indicated and comply with manufacturer's instructions where not otherwise indicated. Install shut-off valve and union on supply and return, drain valve on drain connection.

B. Hydronic Terminals: Install hydronic terminals with hydronic terminal balancing valve and union on outlet; union, shut-off valve on inlet. Install manual air vent valve on element in accordance with manufacturer's instructions. Locate valves and balancing cocks behind valve access doors for ease of maintenance. Where indicated, install automatic temperature control valve with unions between shut-off valve and element on supply line.

C. Install dielectric adaptors between dissimilar metals within hydronic system.

3.8 FIELD QUALITY CONTROL

A. Testing:
   1. Perform pneumatic pressure test isolating equipment, pressure relief valves, pressure reducing valve, and compression tank. Pressurize system to 50 psi for 4 hrs without pressure loss.
   2. If system fails test, locate leaks and retest until leaks eliminated. Replace system components which cannot be fixed with new components.

3.9 CLEANING

A. Flush entire system with clean, clear water, portable water quality, until discharge water runs clear, with no trace of sediment. Clean strainers in air separator and pump suction diffusers and refill system. Operate 1 primary pump and both secondary pumps for minimum of 8 hrs with system valves open, then clean strainers again. If noticeable sediment found in strainers, repeat flushing entire system. Repeat above 8 hr circulation test and check strainers. If strainers have noticeable sediment, repeat flushing and circulation tests until strainers remain clean.

3.10 BALANCING

A. Do not proceed with testing and balancing work until system complete and operable. Ensure no later residual work is still to be completed.

B. Furnish calibrated flow meter and hoses, with suitable conversion charts to set balancing valve installed.

C. Set balancing valves for each boiler, pump, coil, coil bypass, finned tube section, and unit heater for flows indicated on schedules. Mark each balancing valve at set point. Flows $\pm$5% of schedule will be accepted.

D. Balancing Reports:
   1. Provide data on test equipment used and most recent calibration date with submission of test report.
   2. Provide test report signed by test and balance supervisor performing Work, showing scheduled and balanced flow for each balancing valve.

END OF SECTION 23 2113

SECTION 23 2123

HVAC PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install pump and variable speed control systems as required to provide a complete and satisfactory installation.

1.2 SECTION INCLUDES

A. Variable Speed Pump Package.
   1. Horizontal End Suction Pump
   2. Variable Frequency Drives
   3. TEFC or ODP motor
   4. Integral Controls Platform

B. Refer to Division 26 for following; not Work of this section.
   1. Power supply wiring from power source to power connection on pumps. Include starters, disconnects, and required electrical devices, except where specified as furnished or factory-installed by manufacturer.
   2. Interlock wiring between pumps and between pumps and field-installed control devices.
      a. Interlock wiring specified as factory-installed is Work of this section.

C. Provide following electrical work as Work of this section complying with requirements of Division 26.
   1. Control wiring between field-installed controls, indicating devices, and pump control panels.
      a. Control wiring specified as work of Division 23 for Automatic Temperature Controls is Work of that section.

D. See Section 23 0993 for sequence of operation.

1.3 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

	Unit Type	Submittal Information Item
1.	End-suction pumps	1, 2, 3, 4

B. Submittal Information:
   1. Product Data: Manufacturer's pump specifications installation and startup instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
   2. Shop Drawings: Manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly for each model of pump to be provided.

3. Motors: For poly-phase motors 5 hp or larger, submit in accordance with requirements of Section 26 2000 For single-phase motors and poly-phase motors less than 5 hp, submit NEMA design types, construction, insulation class, NEMA frame size, horsepower, voltage and amp draw characteristics, and service factor.
4. Operating and Maintenance (O&M) Data:
    a. Maintenance instructions including lubrication instructions, filter replacement, motor and drive replacement, and spare parts list.
    b. Include O&M data, product data, and Shop Drawings in single-bound manuals.

C. Submit in accordance with Section 01 3300.

D. Information submitted by CONTRACTOR, but not designated to be submitted will be returned without action by ENGINEER.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of general use centrifugal pumps with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Regulatory Requirements:
1. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI Standards" and UL 778.
2. UL and NEMA Compliance: Provide electric motors and components listed and labeled by UL and complying with NEMA standards.

C. Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle HVAC pumps and components to prevent damage, breaking, denting, and scoring. Do not install damaged HVAC pumps or components; replace with new.

B. Store HVAC pumps and components in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading HVAC pumps and moving them to final location.

1.6 WARRANTY

A. Manufacturer's warranty: The entire package shall carry a 18 month parts warranty. The drive will carry a parts and labor warranty. The motor will carry a 12 month parts and labor warranty but must be delivered to a local authorized motor warranty shop by the installing contractor. Manufacturer's warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, the following manufacturers shall be acceptable:
   1. Taco, Inc. – SFI Self-Sensing Series with ProBalance.
   2. Approved Equal.

2.2 MANUFACTURED UNITS

A. The self-sensing product shall consist of a factory supplied base mounted flex-coupled pump with motor and preprogrammed drive with integral controls package.

B. The drive shall be separate and apart to the pump and motor. The mounting of the drive shall be done in a manner consistent with the manufacturer's instructions and all applicable codes.

C. The performance speed of the pump and VFD combination shall be 1750 RPM nominal as standard. Exceptions for 1150 RPM and 3600 RPM shall be noted in the schedules. 3600 RPM shall NOT be an allowable substitution for a specified 1750 RPM or 1150 RPM package. 1750 RPM shall not be an allowable substitution for a specified 1150 RPM or 3600 RPM package. Alternative RPM products might be considered as a substitution for the Specified RPM products only if that manufacturer provides a spare motor, drive, and seal for each pumping unit.

D. Pump logic controller, variable frequency drives, sensor/transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

2.3 COMPONENTS

A. Pump Logic Controller.
   1. The controller operation shall operate the system using a tested and proven program that safeguards against undesirable or damaging conditions including:
      a. Motor overload
      b. Pump flow surges
      c. Hydraulic cycling (hunting).
      d. End of curve unstable operation: The pump logic controller, through a factory pre-programmed algorithm, shall be capable of protecting the pumps from hydraulic damage due to operation beyond their published end-of-curve. This feature requires a flow meter for activation. The operator interface shall include an owner adjustable flow set point to set the parameters for this routine.
   2. The pump logic controller shall be capable of starting, unloading, and stopping pumps based on a system performance program that will minimize energy consumption, provide reliable performance and bumpless transitions.
   3. The pump logic controller shall be capable of running four different hydronic optimization sub-routines
      a. Setup one: This subroutine shall allow the pump package to track a quadratic system curve and will optimize a secondary distribution loop. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
      b. Setup two: This subroutine shall allow two pumps to run as backup for each other and shall alternate the pumps based on a real time clock
      c. Setup three: This subroutine shall allow the package to run in a customer defined flow rate. The package will always seek to run at the user defined flow even with fouling causing system changes. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and

translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.

d. Setup four: This subroutine shall allow the use of a Modulating Pump Controller and shall allow for up to 4 self-sensing pumps to operate in a parallel self-sensing mode.

4. The control platform shall include a subroutine equal to the Taco Self-Sensing Series with ProBalance™. This subroutine shall allow for the automatic balancing of secondary system distribution pumps. The package shall automatically run system distribution pumps to a user defined duty point and will recognize that duty point and hold the pumps at a speed that matches the actual installed system quadratic system curve. The package will then use this data to set up a new duty point as the max point for the quadratic control curve. Use of external balancing devices or contractors will not be needed.
5. The package shall serve as a flow metering device and will display pump flow at the user interface.

B. PUMPS (See pump schedule on plans for exact model, type, and duty points.)

1. Base Mounted Flex Coupled Pumps
   a. Pumps shall be Taco Model FI or approved equal. The pumps shall be single stage end suction rear pull out design. The bearings and seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.
   b. Pump casing shall be constructed of ASTM A48 class 30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.
   c. All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided with that pump to allow servicing.
   d. Pump volute shall be foot mounted. Overhung cantilevered design not allowable.
   e. The pump shall be center line discharge for both positive air venting and allowance for better load distribution.
   f. The pump casing inlet shall have an integrally cast anti-rotational vane.
   g. The impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.
   h. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable bronze SAE 660 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.
   i. The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250ºF. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. Any pump used on an open system shall be furnished with a seal flush line and a Cuno / Kynar / Purocell #900 replaceable cartridge filter or separator with shut-off isolation valve installed in the seal flushing line. The filter shall have the ability to remove particles

down to five microns in size. The entire pump line shall use no more than three different sizes of seals.

j. All pumps to be provided with a fully welded, rigid structural steel base. The base shall include closed ends and top openings to allow for grouting. The base shall include an integral drain pan fabricated from steel with a minimum thickness of 0.1875" and shall contain an integral ¾" drain connection.

k. The pump bearing frame shall incorporate maintenance free permanently lubricated and sealed bearings with an L10 life of 60,000 hours. Bearing frame shall be equipped with Forsheda seals to protect bearings from moisture and airborne contaminants. The entire line of pumps shall use no more than four different sizes of bearing frames.

l. The pump shall be flexibly coupled to a NEMA standard T frame motor. The coupler shall be suitable for across the line starting as well as variable speed conditions associated with variable frequency drives. The coupling shall be equal to a Woods Dura-Flex coupler. Any pump manufacturer providing a mechanically inferior coupler design, especially in variable torque applications, shall extend the warranty of the coupler for an additional two years in addition to their own standard warranty. The coupling and shafts shall be covered by a metal guard. Pump shall be aligned upon receipt at job, during installation, and after system fill by contractor.

m. In order to both simplify and reduce the total cost of ownership, the manufacturer shall standardize on no more than three sizes of mechanical seals and four sizes of bearing frames throughout the entire range of the family of pumps. The manufacturer shall not use multiple part numbers for the same part.

C. VARIABLE FREQUENCY DRIVES

1. The VFD shall convert incoming fixed frequency three-phase ac power into an adjustable frequency and voltage for controlling the speed of three-phase ac motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
2. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
3. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the dc bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) dc link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
4. The VFD's full load output current rating shall meet or exceed NEC table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
5. The VFD shall provide full motor torque at any selected frequency from 20 hz to base speed while providing a variable torque v/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque v/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

6. A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
7. The VFD must be able to produce full torque at low speed to operate direct drive fans.
8. Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
9. An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
10. Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog i/o and discrete digital i/o shall include additional isolation modules.
11. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
12. All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the ac power line.
13. The drive enclosure shall be standard as NEMA 1 (IP 21) for ODP motors and NEMA 12 (IP 55) for TEFC motors. See schedules for project requirements.
14. Protective features
    a. A minimum of class 20 i2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
        1) Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.
        2) Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
        3) Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
        4) Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.
        5) The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.
        6) VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.

7) VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.
8) VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.
9) Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.
10) VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
11) If the temperature of the VFD's heat sink rises to 80°c, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.
12) In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
13) The VFD shall have temperature control cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.
14) The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.
15) When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

15. Internal Control Algorithm
    a. This is a standard HVAC drive that has been upgraded and modified by pump experts for hydronic applications. It is set up with a closed loop internal control sequence that will optimize life cycle, system comfort, and minimize energy consumption.
16. Interface Features
    a. Hand, off and auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
        1) There shall be an "info" key on the keypad. The info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
        2) The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in hand or auto mode. This is to alert the building automation system whether the VFD is being controlled locally or by the building automation system.
        3) Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
        4) All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
        5) To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various

sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

6) Display shall be programmable to communicate in multiple languages including English, Spanish and French.
7) A red fault light, a yellow warning light and a green power-on light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
8) A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual fan, pump, and compressor menus specifically designed to facilitate start-up of these applications.
9) A four-feedback PID controller to control the speed of the VFD shall be standard. This controller shall accept up to four feedback signals. It shall be programmable to compare the feedback signals to a common set point or to individual set points and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
10) The VFD shall be able to apply individual scaling to each feedback signal.
11) For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
12) The VFD's PID controller shall be able to actively adjust its set point based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
13) The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide set point reset.
14) Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
15) Five simultaneous meter displays shall be available. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.
16) Programmable sleep mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into sleep mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up"feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
17) A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.
18) VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°f).

19) VFD shall be programmable to sense the loss of load and signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

17. Standard Control and Monitoring Inputs And Outputs
    a. Six dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
        1) Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
        2) Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
        3) Each relay shall have an adjustable on delay / off delay time.
        4) Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
        5) Each shall be independently selectable to be used with either an analog voltage or current signal.
        6) The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
        7) A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
        8) The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
        9) One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
        10) It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
        11) It shall be possible to command all digital and analog output through the serial communication bus.
18. A real-time clock shall be an integral part of the VFD.
    a. It shall be possible to use this to display the current date and time on the VFD's display.
        1) Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter set points and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
        2) All VFD faults shall be time stamped to aid troubleshooting.
        3) It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
        4) The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
19. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

20. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
    a. Comparators for comparing VFD analog values to programmed trigger values
        1) Logic operators to combine up to three logic expressions using Boolean algebra
        2) Delay timers
        3) A 20-step programmable structure
21. The VFD shall include a cascade controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.
22. Serial communications
    a. The VFD shall include a standard eia-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
        1) Johnson Controls Metasys N2
        2) Modbus RTU
        3) Siemens FLN
        4) BACnet MS/TP
        5) Optional communication shall include:
            a) LonWorks Free Topology (FTP)
            b) VFD shall have standard rs-485 port for direct connection of personal computer (pc) to the VFD. The manufacturer shall provide no-charge pc software to allow complete setup and access of the VFD and logs of VFD operation through the rs-485 port. It shall be possible to communicate to the VFD through this usb port without interrupting VFD communications to the building management system.
            c) The VFD shall have provisions for an optional 24 v DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.
23. Adjustments
    a. The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 khz increments to allow the user to select the desired operating characteristics. The VFD shall also be programable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
        1) Four independent setups shall be provided.
        2) Four preset speeds per setup shall be provided for a total of 16.
        3) Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.
        4) Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.
        5) If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

6) The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
7) An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
8) Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

24. Optional features
    a. All optional features shall be built and mounted by VFD manufacturer. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.
        1) All panels shall be marked for their short circuit current rating in compliance with UL.
25. Service conditions
    a. Ambient temperature, continuous, full speed, full load operation:
        1) 10 to 45°C (14 to 113°F) through 125 hp @ 460 and 600 volt, through 60 hp @ 208 volt
        2) 10 to 40°C (14 to 104°F) 150 hp and larger
        3) 0 to 95% relative humidity, non-condensing.
        4) Elevation to 3,300 feet without derating.
        5) AC line voltage variation, -10 to +10% of nominal with full output.
        6) No side clearance shall be required for cooling.
        7) All power and control wiring shall be done from the bottom.
        8) All VFDs shall be plenum rated.

2.4 MOTORS

A. Except where more stringent requirements indicated in unit Specifications or equipment schedules, provide manufacturer's standard motor complying with following requirements.

B. Definite-Purpose Motors: Provide in accordance with NEMA MG 1-18.

C. General Purpose, Poly-Phase Motors 5 hp and Larger: Provide in accordance with NEC requirements.

D. Singe-Phase Motors: Unless otherwise indicated, for motor requirements less than 1/2 hp, provide single-phase motors conforming to following.
1. Type: Continuous duty, squirrel cage, induction, fractional horsepower motors, rated in accordance with NEMA MG1-10.33.
    a. 1/6 to 1/3 hp: Permanent-split capacitor with internal overload protection, NEMA N or O as determined appropriate for application by equipment manufacturer.
    b. 1/3 hp and Larger: 2-valve capacitor, NEMA L, M, N or O as determined appropriate for application by equipment manufacturer.
2. Enclosure Classification: Open, drip-proof machine, as defined in NEMA MG-1, unless otherwise indicated.
3. Insulation Class Rating:
    a. Fractional horsepower motors: Class A.
    b. Integral horsepower motors: Class B.

c. Definite purpose motors: Class A, B, F or H as determined appropriate for application by equipment manufacturer.

E. Poly-Phase Motors:
1. Type: Continuous duty, squirrel cage, induction, fractional and integral horsepower motors, rated in accordance with NEMA MG1-10.33.
a. 1/3 to 3 hp: NEMA B or C as determined appropriate for application by equipment manufacturer.
b. Where rated motor loads produce uncorrected motor power factors less than 0.90, provide capacitors for power factor correction to 0.95.
2. Enclosure Classification: Open, drip-proof machine, as defined in NEMA MG-1, unless otherwise indicated.
3. Insulation Class Rating: Suitable for continuous operation in 40°C environment, tested in accordance with IEEE 112 and 114.
a. Fractional horsepower motors: Class A.
b. Integral horsepower motors: Class B.
c. High starting torque motors: Class F.
d. Definite purpose motors: Class A, B, F or H as determined appropriate for application by equipment manufacturer.

F. Service Factor: Minimum 1.15 for NEMA A, B, and C poly-phase motors, in accordance with NEMA MG1-12.47 for fractional horsepower motors.

G. Bearings: Permanently lubricated ball or regreasable sleeve bearings with inner and outer shaft seals, designed to resist thrust loadings.

H. Efficiency: Provide high efficiency poly-phase motors in accordance with IEEE 112, Test Method B.

I. Variable Frequency Drive Applications: Provide special purpose, high efficiency motors specifically constructed for use with, and matched to, variable frequency drive. NEMA B, Class F insulation with non-wicking motor leads and copper windings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which HVAC pumps to be installed. Do not proceed with Work until unsatisfactory conditions corrected.

3.2 INSTALLATION OF PUMPS

A. Install HVAC pumps in accordance with manufacturer's written installation instructions, complying with recognized industry practices to ensure HVAC pumps comply with requirements and serve intended purposes.

B. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than recommended by manufacturer.

C. Support:

1. On Grade/ Basement Concrete Floors: Install base-mounted pumps on minimum 4 in. high concrete base equal or greater than 3 times total weight of pump and motor with anchor bolts poured in-place. Set and level pump and grout under pump base with non-shrink grout.
2. In-line pumps: Support from piping system.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.
1. Verify electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26.

E. Piping Connections: Provide full line size isolation valve and strainer or suction diffuser on pump suction. Provide full line size check valve, balance valve, and flow measuring device on pump discharge.

F. Where pump connection size and indicated line size are not identical, provide concentric reducers for vertical and eccentric reducers for horizontal connections. Install eccentric reducers with top of pipe level.

3.3 ADJUSTING AND CLEANING

A. Alignment: Check alignment and, where necessary, realign shafts of motors and pumps within misalignment tolerances recommended by manufacturer, but not exceeding 0.004 in. in axial and angular planes. Align in presence of manufacturer's service representative.

B. Startup: Lubricate pumps before startup. Startup in accordance with manufacturer's instructions.

C. Refer to Section 23 0593 for pump system balancing.

D. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

3.4 DEMONSTRATION

A. The control package manufacturer's factory trained representative shall provide start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the Owner or Owner's designated representative. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.

B. The pump control package manufacturer's factory trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

END OF SECTION 23 2123

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SECTION 23 3010

AIR DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal ductwork.
2. Equipment housings.
3. Control dampers.
4. Manual dampers.
5. Fire Dampers
6. Turning vanes.
7. Duct hardware.
8. Duct access doors.
9. Flexible connections.
10. Registers and grilles.
11. Louvers.

1.2 DEFINITIONS

A. Low Pressure Ductwork: Ductwork subjected to velocities of 2,500 fpm or less, or operating pressures of 2 in. or less, positive or negative.

1.3 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

Description	Submittal Information Item
Metal ductwork	1
Control dampers	1,2
Fire dampers	1
Turning vanes	1
Duct hardware	1
Duct access doors	1
Flexible connections	1
Registers and grilles	1,2
Louvers	1,2

B. Submittal Information:
1. Product Data: Manufacturer's specifications for equipment showing dimensions, weights, capacities, ratings, performance characteristics, gauges, color and finish of materials, and installation instructions.
2. Shop and Assembly Drawings: Show unit dimensions, construction details, and field connection details.

C. Submit in accordance with Section 01 3300.

1.4 QUALITY ASSURANCE

A. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with nonmetallic ductwork systems similar to that required for Project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect shop-fabricated and factory-purchased ductwork, accessories, and purchased products from damage during shipping, storage, and handling. Prevent end damage and dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer's equipment used as basis of design for Project is name indicated in schedule. Where schedule not provided, basis of design is name indicated in Specification for particular type of equipment or application contained in these Contract Documents. If no manufacturer listed, basis of design is industry standard indicated.

2.2 METAL DUCTWORK

A. Provide metal ductwork as noted on the drawings and as specified below:
   1. Sheet Metal: Comply with ASTM A527, lock-forming quality, with ASTM A525, G90 zinc-coating; mill phosphatized for exposed locations.
   2. Aluminum Sheet: Comply with ASTM B209, Alloy 3003, Temper H14.
   3. Stainless Steel Sheet: Comply with ASTM A167, ANSI type 316 with No. 2B finish.
   4. Duct Sealant: Non-hardening, non-migrating mastic or liquid elastic sealant (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.
   5. Duct Cement: Non-hardening migrating mastic or liquid neoprene based cement (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
   6. Ductwork Support Materials:
      a. For galvanized steel ductwork, provide hot-dipped galvanized steel fasteners, anchors, rods, trim and angles for support of ductwork.
      b. For aluminum ductwork, provide aluminum support materials except where materials electrolytic ally separated from ductwork.
      c. Provide matching stainless steel support materials for exposed stainless steel ductwork.

B. Shop or Factory Fabrication:
   1. Fabricate shop or manufactured duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Fabricate mitered fittings to include turning vanes unless noted without turning vanes.
   2. Fabricate ductwork of gauges and reinforcement complying with SMACNA "Low Pressure Duct Standards for 2.0 in. wg Pressure Class." unless otherwise indicated.

3. Ductwork shall be sealed at all joints/ connections, both transverse and longitudinal seams complying with IMC and IECC sealing requirements. All ductwork shall be sealed using Class B seal.
4. Fabricate ductwork with accessories installed during fabrication to greatest extent possible.
5. Fabricate fan housings and air plenums with minimum 16 gauge thickness of materials specified.

C. Application:
1. Provide galvanized steel ductwork for:
   a. Outside air intake and exhaust.
   b. Intake/exhaust air plenums.
   c. Fan housings.
   d. Dual temperature ductwork located inside Membrane Room and Electrical Room.
2. Provide aluminum ductwork for:
   a. Toilet Room exhaust.
3. Provide stainless steel ductwork for:
   a. Rectangular exhaust/outside air intakes located inside Chemical Rooms.
4. Provide PVC ductwork for:
   a. Chemical Room exhaust; See Section 23 3116 – Non-metallic Ductwork.

2.3 MOTOR OPERATED CONTROL DAMPERS – RECTANGULAR, LOW LEAKAGE, HIGH PERFORMANCE

A. Manufacturers:
1. Ruskin Manufacturing.
2. Arrow United Industries.
3. Louver and Dampers; A Mastek Company.
4. Or equal.

B. Motor Operated Dampers: Provide low leakage, high performance dampers. Dampers to be constructed of materials listed below. Provide dampers of similar or matching materials as adjoining ductwork, or as indicated on drawings.
1. Model CD30VG1:
   a. Frame: 3-in. x 1-in. x 12 gage stainless steel U channel. Provide mounting flanges on both sides of frame.
   b. Blades: 16 gage 304 stainless steel triple-V groove, 8-in wide.
   c. Seals: EPDM blade seals. Blade seals shall be mechanically fastened to the blade. Leakage shall not exceed 4.3 CFM per square foot at 1-in. SP.
   d. Bearings: Stainless steel pressed into frame.
   e. Linkage: Stainless steel face linkage in airstream.
   f. Axles: 1/2-in. diameter 304 stainless steel.
   g. Operator: Stainless steel mounting plate for operator and stainless steel mounting hardware.
   h. Blade operation: Opposable blade for modulating control, Parallel blade for 2 position dampers.
   i. Operating Temperature Range: -76°F to 250°F.

2.4 VOLUME DAMPERS – ROUND, PVC

A. Manufacturers:
   1. Harvel Plastics, Inc. - Easton, PA.
   2. Harrison Machine and Plastic Corporation - Garrettsville, OH.
   3. Viron International Corporation - Owosso, MI.
   4. Or equal.

B. Provide butter fly balancing dampers of size indicated on Drawings, constructed of all PVC, ASTM D - 1784. Butterfly balancing dampers shall be provided with locking quadrant to permanently position damper blade.

2.5 FIRE DAMPERS

A. Manufacturers:
   1. Ruskin Manufacturing.
   2. Or equal.

B. Fabricated Fire Dampers: Provide dampers constructed in accordance with SMACNA "Fire Damper and Heat Stop Guide" and UL listed.

C. Fire Dampers: Provide curtain type dynamic fire dampers of sizes and ratings indicated on drawings. Fire dampers can be installed either vertically in walls or horizontally in masonry floors. Provide fire dampers of similar or matching materials as adjoining ductwork, or as indicated on drawings.

D. Model DIBD2 or DIBD2SS Style A.
   1. Rating: 1-1/2 hour.
   2. Frame and Blade: Galvanized Steel or Stainless Steel.
   3. Closure Spring: 301 stainless steel constant force or spring clip type.
   4. Fusible link: 165ºF closure temperature.
   5. Provide factory sleeve to meet UL installation requirements.
   6. Provide G Style for grille mounting applications as indicated on drawings.

E. Provide duct access door at each fire damper location.

2.6 TURNING VANES

A. Manufacturers:
   1. Aero Dyne Company.
   2. Duro Dyne Corporation.
   3. Or equal.

B. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2 in. wide curved blades set at 3/4 in. on center, supported with bars perpendicular to blades set at 2 in. on center, and set into side strips suitable for mounting in ductwork. Material to match ductwork.

2.7 DUCT HARDWARE

A. Manufacturers:
   1. Ventfabrics, Inc.

2. Young Regulator Company.
3. Duro Dyne Corporation.
4. Or equal.

B. Test Holes: Provide in ductwork at fan inlet, outlet, and elsewhere as indicated, duct test holes consisting of slot and cover for instrument tests.

C. Quadrant Locks: Provide for each manual damper, quadrant lock device on one end of shaft and end bearing plate on other end for damper lengths over 12 in. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.8 DUCT ACCESS DOORS

A. Manufacturers:
1. Ruskin Manufacturing Company.
2. Duro Dyne Corporation.
3. Ventfabrics, Inc.
4. Or equal.

B. Construction: Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with 1 handle type latch for doors 12 in. high and smaller, 2 handle type latches for larger doors.

2.9 FLEXIBLE CONNECTIONS

A. Manufacturers:
1. Duro Dyne Corporation.
2. Ventfabrics, Inc.
3. Or equal.

B. Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

2.10 REGISTERS AND GRILLES

A. Manufacturers:
1. Titus Products, Division of Philips Industries, Inc.
2. C.G. Carnes Company, Division of Wehr Corporation.
3. Or equal.

B. Provide manufacturer's standard wall registers and grilles where shown of size, shape, capacity, and type indicated constructed of materials and components as scheduled and required for complete installation.

C. Performance: Provide wall registers and grilles having, as minimum, temperature and velocity traverses, air throw, pressure drop, and noise criteria ratings for each size device listed in manufacturer's current data.

D. Register and Grille Materials:
   1. Steel Construction: Manufacturer's standard steel frames and blades.
   2. Aluminum Construction: Manufacturer's standard extruded aluminum frames and blades.
   3. Stainless Steel Construction: Manufactures standard stainless steel frame and blades.

E. Register and Grille Faces: Provide fixed, single deflection, or double deflection blades as scheduled.

F. Register and Grille Mountings: Perimeter framed register or grille suitable for T-bar lay-in mounting or surface mounting as scheduled.

G. Dampers: Provide aluminum opposed blade dampers as scheduled.

H. Register and Grille Finishes: Provide manufacturers standard, baked white enamel finish, unless specified otherwise.

2.11 LOUVERS

A. Manufacturers:
   1. Ruskin Manufacturing Company.
   2. Greenheck Company.
   3. Industrial Louvers, Inc.
   4. Louvers and Dampers; A Mastek Company.
   5. Or equal.

B. Except as otherwise indicated, provide manufacturer's standard louvers where shown of size, shape, capacity, and performance equal to Ruskin Model ELF6375DX. Construct of materials and components as indicated and required for complete installation.

C. Performance: Provide weatherproof louver with performance characteristics as scheduled.

D. Louver Depth: 6-in.

E. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate and specifically manufactured to fit into construction openings with accurate fit and adequate support for weatherproof installation. Refer to Drawings and Specifications for types of substrate which will contain each type of louver.
   1. Provide extended sill as scheduled.

F. Materials: Construct of aluminum extrusions, ASTM B221, Alloy 6063-T52. All welded construction.

G. Louver Screens: On inside face of exterior louvers, provide 1/2 in. sq. mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

H. Finish: Provide louvers with Ruskin’s superior finish FLUROPON, 70% PVDF paint finish, carbon/ fluorine bond, manufacturer 20-year warranty. All standard colors meet or exceed AAMA 2605-11. Louver color shall be selected by OWNER.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate layout with suspended ceiling and lighting layouts and similar finished Work.

B. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls, and other associated items of ductwork system.

3.2 INSTALLATION OF DUCTWORK AND EQUIPMENT SLEEVES

A. Locate ductwork runs, except as otherwise indicated, vertically and horizontally, avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, run ductwork in shortest route not obstructing usable space or block access for servicing building and equipment. Install close to walls, overhead construction, and other structural and permanent enclosure elements of building.

B. Complete fabrication of Work at Project necessary to match shop-fabricated work and accommodate installation requirements.

C. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8 in. misalignment tolerance and with internal surfaces smooth.

D. Support ductwork with suitable ties, braces, hangers, and anchors of type holding ducts true to shape and preventing buckling. Comply with SMACNA "HVAC Duct Construction Standards". Ductwork hangars shall be two rod trapeze type incorporating a structural or bent metal angle. Strap type hangers are not allowed.

E. Assemble, install, and seal ductwork in accordance with recognized industry practices to achieve airtight (less than 5% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service.

3.3 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction shown in SMACNA standards, and in accordance with recognized industry practices to ensure products serve intended function.

B. Install turning vanes in all square and rectangular 90° elbows.

C. Install access doors to open against system air pressure. Install access doors at each automatic control damper and at both side of fire dampers.

D. Install motor operated dampers within or as close as possible to building envelope elements including roof decks and exterior walls.

3.4 CLEANING AND PROTECTION

A. Clean ductwork internally, unit by unit as installed, of dust and debris. Clean external surfaces of foreign substances.

B. Temporary Closure: At ends of ducts not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering to prevent entrance of dust and debris until time connections are completed.

END OF SECTION 23 3010

SECTION 23 3116

NON-METALLIC DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. PVC Ductwork.

1.2 DEFINITIONS

A. Low Pressure Ductwork: Ductwork subjected to velocities of 2,500 fpm or less, or operating pressures of 2 in. or less, positive or negative.

B. High Pressure Ductwork: Ductwork subjected to velocities of 2,500 to 4,000 fpm, or operating pressures of 2 in. or greater, positive or negative.

1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer's specifications for duct system materials showing dimensions, thicknesses, weights, materials of construction, corrosion resistance characteristics, and method of construction.

B. Record Drawings: At Project closeout, submit record drawings of installed ductwork, duct accessories, and outlets and inlets in accordance with Section 01 7700.

C. Submit in accordance with Section 01 3300.

1.4 QUALITY ASSURANCE

A. Installer's Qualifications: Firm with at least 3 yrs successful installation experience on projects with nonmetallic ductwork systems similar to that required for Project.

B. Regulatory Requirements:
   1. SMACNA Standards: Comply with SMACNA - "Fibrous Glass Duct Construction Standards - 2003" and SMACNA - "Thermoplastic Duct Construction Manual - 1997" for fabrication and installation of thermoplastic ductwork.
      a. Have available at CONTRACTOR'S field office, copy of SMACNA - "Fibrous Glass Duct Construction Standards" and SMACNA - "Thermoplastic Duct Construction Manual".
   2. ASHRAE Standards: Comply with ASHRAE Handbook and Product Directory, 2008 HVAC Systems and 1983 Equipment Volume, Chapter 18, "Duct Construction," for fabrication and installation of nonmetallic ductwork.
   3. NFPA Compliance: Comply with NFPA Nos. 90A, 90B, and 91.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect shop-fabricated and factory-purchased ductwork, accessories, and purchased products from damage during shipping, storage, and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC DUCT MATERIALS

A. Provide factory fabricated materials, free from visual imperfections including dents, cracks, discolorations or other imperfections.

B. Thermoplastic Sheet: Stress relieved ASTM D1784, Class 12454B (formerly Type 1, Grade 1).

C. Thermoplastic Round Duct:
   1. 20 in. diameter and Smaller: Seamless, extended ASTM D1784, Class 12454B (formerly Type 1, Grade 1).
   2. Larger than 20 in. diameter: Longitudinal seam, hot gas welded ASTM D1781, Class 12454B (formerly Type 1, Grade 1), bell and spigot joint.
   3. Strap Hangers: Minimum support spacing in accordance with Table 15843-1, 180° contact.
   4. Flanges: Thickness, bolt pattern in accordance with Table 1.
   5. Sealer: Non-hardening, non-migrating silicon based of type recommended by duct manufacturer for application.
   6. Gaskets: Minimum 0.125 in. thickness, non-hardening, chemically resistant, suitable for intended purpose.

2.2 THERMOPLASTIC DUCTWORK FABRICATION

A. Provide miscellaneous materials and products of types and sizes indicated, and where not otherwise indicated, provide type and size required to comply with ductwork system requirements, including proper connection of ductwork and equipment furnished under other sections.

B. Shop-fabricate ductwork in accordance with SMACNA - “Thermoplastic Duct Construction Manual”.

C. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centerline radius equal to 1.5 times duct width in plane of elbow. Limit includes angular taper to 45^{o} for contracting tapers and 30^{o} for expanding tapers.

D. Provide flanged connections for equipment mounted in thermoplastic ductwork for ease of removal and where joining to dissimilar materials. Join flanges with elastomeric gasket material, non-corrosive fasteners and seal to provide airtight, moisture tight joint.

E. Fabricate round ductwork in accordance with Table 1 to this section.

F. Fabricate and reinforce rectangular ductwork for pressure glass indicated on Drawings in accordance with SMACNA - “Thermoplastic Duct Construction Manual”.

2.3 THERMOPLASTIC DUCTWORK APPLICATION

A. Provide thermoplastic ductwork for exhaust fan systems from point of collection to building exit for the following areas:
   1. R107 - Corrosion Inhibitor
   2. R108 - Sodium Hydroxide
   3. R109 - Sodium Bisulfite
   4. R110 - Antiscalant

B. Do not use thermoplastic ductwork in following applications.
   1. Outdoors.
   2. Where velocities or pressures exceed manufacturer's published limitations.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

A. Assemble and install ductwork in accordance with recognized industry practices to achieve airtight (less than 5% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8 in. misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type holding ducts true to shape and preventing buckling.

B. Pressure Class: Construct fibrous ductwork of SMACNA pressure class indicated on Drawings, or if not indicated, in accordance with following.
   1. Low Pressure Duct Systems:
      a. Constant volume supply, return, exhaust systems, and air transfer ductwork not employing air terminal devices with fan static pressures not greater than 2 in. wg and velocities not greater than 2,500 fpm. Construction to pressure classification equal to or greater than rated pressure of system fan.
      b. Variable volume supply and return systems with velocities not greater than 2,500 fpm.
         1) Downstream of supply air terminal devices: 1 in. wg class.
         2) Return air ductwork upstream of return fan: 1 in. wg class.
   2. High Pressure Duct Systems:
      a. Constant volume or variable volume distribution supply, return ductwork between fan, and air terminal devices less than 4,000 fpm of velocity. Construct to pressure class equal to stall static pressure of fan at manufacturer's rated fan speed for indicated capacity if fan stall pressure does not exceed 3 in. wg. If fan stall pressure exceeds 3 in. wg, use metallic ductwork.
      b. Constant volume supply and return system ductwork with fan static pressure exceeding 2 in. wg or velocities exceeding 2,500 fpm. Construct entire system to minimum pressure class equal to or greater than highest total pressure of air in duct system.

C. Seal ductwork, after installation, to seal class recommended and method prescribed in SMACNA.
   1. "Thermoplastic Duct Construction Manual."

D. Install concrete inserts for support of ductwork in coordination with formwork to avoid delays in Work.

E. Complete fabrication of Work at Project necessary to match shop-fabricated Work and accommodate installation requirements.

F. Locate ductwork runs, except as otherwise indicated, vertically and horizontally, avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2 in. where furring shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1 in. clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

G. Coordinate layout with suspended ceiling and lighting layouts and similar finished Work.

H. Electrical Equipment Space: Do not run ductwork through transformer vaults and their electrical equipment spaces and enclosures.

I. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct with sheet metal flanges. Overlap opening on 4 sides by at least 1-1/2 in.

J. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls, and other associated with ductwork system.

K. Support ductwork in manner complying with SMACNA.
   1. SMACNA - “Thermoplastic Duct Construction Manual”
   2. Support PVC ductwork from strap hangers with minimum 180° contact of duct surface in accordance with NBS PS 15-69.

L. Provide frames constructed of angles, channels or flanges for coils, filters, dampers or other devices installed in duct systems and make final connections to items furnished under other systems. Secure frames with gaskets, nuts, bolts, and washers.

3.2 CLEANING AND PROTECTION

A. Clean ductwork internally, unit by unit as installed, of dust and debris. Clean external surfaces of foreign substances where ductwork is to be painted, which might interfere with painting or cause paint deterioration.

B. Temporary Closure: At ends of ducts not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering to prevent entrance of dust and debris until connections complete.

3.3 FIELD QUALITY CONTROL

A. Balancing:
   1. Conform to Section 23 0593 for air distribution balancing.
   2. Seal leaks in ductwork that become apparent in balancing process.

B. Leakage Testing: Fibrous glass ductboard systems.
   1. After each duct system complete, test for duct leakage in accordance with Section 23 0593.

2. Repair leaks and repeat tests until total leakage less than 5% of system air flow.

C. Leakage Testing: Thermoplastic duct systems.
1. After each duct system completed, test for duct leakage in accordance with Section 23 0593.
2. Repair leaks and repeat tests until total leakage less than 1% of system air flow.
   a. Repair leaks in thermoplastic materials by fusion with thermoplastic filler materials.
   b. Repair leaks in FRP materials by hand lay-up method.
   c. Repair leaks between dissimilar materials with non-hardening sealer. Provide thermoplastic filler material when opening to be sealed exceeds thickness of duct material used.

TABLE 1 to Section 23 3116
MINIMUM POLY VINYL CHLORIDE (PVC)
ROUND DUCT DIMENSIONS

Size	Wall Thickness	Flange OD Diameter	Flange Thickness	Bolt Circle Dia	Bolt Hole Dia	No. of Bolt Holes	Duct Spacing Supports	Duct OD
4	0.187	8.375	0.25	7	7/16	4	10	4.50
6	0.187	10.375	0.25	9	7/16	8	10	6.625
8	0.187	12.375	0.25	11	7/16	8	10	8.625
10	0.187	14.375	0.375	13	7/16	12	10	10.750
12	0.187	16.375	0.375	15	7/16	12	9-1/2	12.750
14	0.187	18.375	0.375	17	7/16	12	9-1/2	14.000
16	0.187	20.375	0.50	19	7/16	16	8-1/2	16.000
18	0.187	22.375	0.50	21	7/16	16	8-1/2	18.000
20	0.187	24.375	0.50	23	7/16	20	8	20.375
22	0.187	26.375	0.50	25	7/16	20	7-1/2	22.375
24	0.187	28.375	0.50	27	7/16	20	7-1/2	24.375

END OF SECTION 23 3116

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SECTION 23 3400

FANS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Centrifugal ceiling exhausters.
2. Commercial ceiling fans.
3. Polypropylene utility blowers.
4. Variable frequency drives.

B. Refer to Division 26 for following; not Work of this section.
1. Power supply wiring from power source to power connection on fan motor. Include starters, disconnects, and required electrical devices, except where specified as furnished or factory-installed, by manufacturer.

C. Provide following electrical work as Work of this Section, complying with requirements of Division 26.
1. Interlock control wiring between fan units and field-installed control elements, indicating devices, and unit control panels.

1.2 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

Unit Type	Submittal Information Item
Centrifugal ceiling exhaust fans	1,2,3,4,5,6
Commercial ceiling fans	1,2,3,4,5,6
Polypropylene utility blowers	1,2,3,4,5,6
Variable frequency drives	1,2,3,4,5,6

B. Submittal information:
1. Product Data: Submit manufacturer's technical data for fans, including specifications, capacity ratings, certified sound power data, dimensions, weights, materials, accessories furnished, and installation instructions. Submit fan performance curves with operating point clearly indicated.
2. Shop Drawings: Submit assembly type drawings showing fan dimensions, required clearances, construction details, assembly of component methods, and field connection details.
3. Shop Drawings, Wiring Diagrams: Manufacturer's electrical requirements for power supply wiring to fans.
4. Shop Drawings, Wiring Diagrams: Manufacturer's ladder type for interlock and control wiring. Differentiate between portions of wiring factory-installed and portions to be field-installed.
5. Motors: For poly-phase motors 5 hp and larger, submit in accordance with Section 26 2000. For single-phase, definite purpose, special purpose and general purpose poly-phase motors less than 5 hp, submit NEMA design types, construction, insulation class, NEMA frame size,

horsepower, voltage and amp draw characteristics, and service factor for each common application.

6. Operating and Maintenance (O&M) Data:
   a. Maintenance instructions including lubrication instructions, filter replacement, motor and drive replacement, troubleshooting guide and spare parts lists.

C. Submit in accordance with Section 01 3300.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fans of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 yrs.

B. Regulatory Requirements:
   1. AMCA Compliance: Provide power ventilators which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Ratings Seal.
   2. UL Compliance: Provide power ventilators UL listed and having UL label affixed.
   3. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

1.4 MAINTENANCE

A. Spare Parts:
   1. Furnish 1 spare set of belts for each belt driven fan provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL CEILING EXHAUSTERS

A. Manufacturer's:
   1. Greenheck Fan Corporation.
   2. Cook (Loren) Company.
   3. Broan Manufacturing Company, Inc.
   4. PennBarry Company.
   5. Or equal.

B. Provide fan with AMCA certified ratings seal.

C. Type: Galvanized steel housing lined with acoustical insulation, adaptable for ceiling or wall installation. Centrifugal fan wheels mounted on motor shaft with fan shrouds, removable for service. Provide integral back draft damper at fan discharge.

D. Grille: Aluminum louvered grille with flange on intake with thumbscrew attachment to fan housing, white enamel finish.

E. Motor: Definite purpose, open drip-proof, permanently lubricated scintered bronze bushings with grounded cord and plug.

F. Electrical: Junction box for electrical connection on housing, and receptacle for motor plug-in.
   1. Furnish remote fan speed control, solid state, capable of controlling fan speed from full speed to approximately half speed.

G. Accessories: Provide following accessories as indicated and as scheduled.
   1. Motor with thermal overload.
   2. UL/cUL 507 listed – Electric Fan.
   3. Polypropylene wheel.
   4. Hooded wall cap.
   5. Round duct connection.
   6. Isolation kit.

2.2 COMMERCIAL GRADE AXIAL CIRCULATION FANS

A. Manufacturers:
   1. Northwest Envirofan Corporation.
   2. Or equal.

B. Provide factory fabricated circulation fans of size indicated with capacities and accessories as detailed, scheduled or specified.

C. Fan Units Construction: Factory assembled and tested consisting of cast iron motor housing, fan motor/ drive, 10 in. down rod with 3/4 in. diameter, aluminum curved 56 in. fan blades, manufacturer furnished support bracket, 13 in. secondary support safety cable, manufacturer's standard superior corrosion resistant finish.

D. Electrical: Unit to be provided with 16 in. 120 volt power cord with three prong plug.

E. Controls:
   1. Equipped with on/off/variable speed controller with reversing switch. See equipment schedule for multiple-fan operation requirements.

2.3 POLYPROPYLENE UTILITY BLOWERS

A. Manufacturer's:
   1. Plastec Ventilation, Inc.
   2. Industrial Plastic Fan.
   3. Or equal.

B. Provide factory fabricated polypropylene exhaust utility blowers of size indicated with capacities and accessories as detailed, scheduled or specified.

C. Construction: Housing shall be constructed of a single molded piece; strong high-density UV treated polypropylene for maximum corrosion resistance. Housing shall be reversible and rotatable to the discharge position shown on drawings.

D. Impeller/Wheel: Impeller/ Wheels shall be of forward-curved type and constructed of uniformly molded polypropylene blades and shall be electronically and dynamically balanced. Blower impeller/ wheel shall be supplied with a motor shaft bushing and hubcap constructed from polypropylene to protect shaft end.

E. Motor Support: Provide polypropylene or grey powder coated cast aluminum motor support for complete motor protection shall be provided as specified or as scheduled.

F. Motors: Motors shall be direct drive and of heavy-duty ball bearing type for continuous duty with voltage as scheduled. Motors shall be totally enclosed fan cooled (TEFC). Motors shall be UL and CSA approved.
   1. Provide high efficiency motor, inverter duty rated.

G. Performance: Fan performance shall be based on tests conducted in accordance with AMCA 210-85 and shall meet scheduled fan performance as scheduled.

H. Warranty: Provide two year manufacturer warranty including defects in material and workmanship from date of original shipment.

I. Accessories:
   1. 316 stainless steel metal stand.
   2. 316 stainless steel mounting brackets, wall mounted, shop fabricated by contractor.
   3. Nema-4X disconnect switch.
   4. PVC back draft damper.
   5. PVC volume damper.
   6. Variable Frequency Drive w/ Nema-4X enclosure.

2.4 Variable frequency Drives

A. Variable Frequency Drives: Variable frequency drives for the ¾ and 1/3 HP fans associated with fans(s) EF-1, EF-2, EF-3 and EF-4 are to be supplied by ABB, AC Tech, Cutler Hammer, Yaskawa, or Toshiba and HVAC / drive control wiring interface to be provided by approved System Integrators / Contractors (OnDrive Inc., HTS, EFI, Toshont Power Products or approved equivalent). Refer to HVAC control drawings and electrical drawings (where applicable) for functional description of HVAC / drive control wiring interface as basis for providing panel integrator drawings forming part of shop drawing submission. Provide approved VFDs with horsepower ratings to match the fan motors as indicated on the drawing schedules and complete with features and characteristics as follows:
   1. Suitable for 480 volt, 3-phase power supply with available fault level of 20,000 amperes and voltage variation of +15 percent and –10 percent.
   2. All VFDs of 25 HP and lower shall be supplied complete with Hammond RM Series or MTE three phase input line reactors or approved equivalent, required to provide line transient voltage protection. A minimum of 5 percent is required.
   3. All VFDs of 30 HP and above shall be equipped with MIRUS International Inc. LINEATOR™ Universal Harmonic Filter (UHF), MTE Matrix Filter or approved equivalent to reduce total harmonic current and voltage distortion to the limits specified by Standard IEEE 519 1992 at the input terminals of the harmonic filters. Input line reactors are not acceptable. A single Lineator is acceptable for both the supply and return fans.
   4. The VFD shall be of the fully digital pulse width modulated (PWM) type utilizing insulated gate bipolar transistors (IGBTs) in the inverter section of the VFD. The VFD shall accept AC line voltage variation of +10 percent to -15 percent. No transformers shall be used on either the input or output of the VFD.
   5. Displacement Power Factor: 0.98 over entire range of operating speed and load.
   6. Minimum Efficiency: 96 percent.
   7. Overload Capacity: 120 percent for Variable Torque Application and 150 percent for 1 minute for Constant Torque Applications.
   8. All drive parameters (set up, operating and adjustment settings) to be entered via keypad, without tools. Three adjustable setpoints to lock out continuous operation at frequencies which may produce mechanical resonance. Drive to be capable of determining the speed and

direction of a spinning motor and adjusting its output to "pick-up" the motor at the rotating speed. The flying start feature is to be operable with, or without, encoder feedback.

9. Provide NEMA 4X wall mounted enclosure for indoor applications located in Process and Basement Areas suitable for rack mounting, designed to provide electromagnetic shielding. Provide a Hand-Off-Auto switch on face of panel for control of VFD's as per HVAC control drawings.
10. NEMA 12 or Open (Protected) Chassis VFD with keypad/display installed through the door of the VFD panel enclosure (accessible on outside face of door).
11. Provide incoming, horsepower rated, disconnect switch with an operating mechanism.
12. Provide input line fuses coordinated with the VFDs electronic protection circuits so as not to blow under normal output faults such as overcurrent, short circuit and ground fault.
13. Provide output line reactors if the distance between the VFD and motor is greater than 160 feet.
14. Three contactor type by-pass arrangement and overloads to permit fan operation if VFD is faulty, with by-pass mode selected manually at the front of the VFD panel. On VFD units that are supplied complete with Lineator UHF units, the UHF must be electrically by-passed with the VFD (does not apply where a single Lineator is used for multiple drives).
15. When the Hand-Off-Auto switch is in either the "Hand" or "Auto" position, fan start is interlocked with the corresponding fan damper actuators end switch.
16. In both "Hand" and "Auto" mode, fan start is interlocked with a damper end switch, and the VFD is to ramp (adjustable to 90 seconds) the fan to a preselected slow speed when the remote damper end switches closes.
17. If the Hand-Off-Auto switch is in "Auto" the fan ramps up to its currently assigned speed setting over an adjustable time period (up to 90 seconds). If the Hand-Off-Auto switch is in "Hand" the fan ramps up to the minimum speed setting and is controlled thereafter from the VFD keypad display

B. Protection:
   1. Provide the VFD with internal protection features.
   2. Fault Sensing shall include but not be limited to:
      a. Power On
      b. Overload protection
      c. Overcurrent Protection
      d. Short Circuit Protection
      e. Inverter Fault
      f. External Fault
      g. Over Voltage
      h. Under Voltage and Phase Loss
      i. DC Bus Under-voltage/over-voltage Protection
      j. Over Temperature Protection
      k. Power Semi Conductor Protection
      l. Ground Fault Protection
      m. Heatsink over temperature Protection
      n. Output phase to phase & phase to ground short circuit protection

C. Environment:
   1. The VFD shall have the following minimum environmental tolerances.
      a. Ambient temperature range of 32 degrees F to 104 degrees F. Units located in non-heated areas shall be provided with thermostatically controlled heated weather enclosure.
      b. Maximum humidity of 95 percent non-condensing.

c. Maximum altitude of 1000 m for rated output.

D. Performance:
1. The VFD shall automatically restart after an inverter fault trip. The VFD shall attempt to restart automatically 5 times with Lockout after the third attempt if a restart has not occurred.
2. The VFD shall have automatic/manual signal follower for 4-20 mA or 0-10 VDC reference.
3. All drive parameters (set up, operating and adjustment settings) to be entered via keypad without tools.
4. "Ride through" of short power interruptions.
5. Auto restart following fault, except for ground and short circuit faults. The drive shall shut down and annunciate any fault conditions (as a minimum) and display the appropriate fault code on the display of the keypad.
6. Automatic/manual selection (Hand-Off-Auto) in manual or hand control, drive speed shall be controlled via the keypad. In automatic control drive speed shall be controller via 4-20 mA and/or a 0-10 VDC signal from the BMS (BMS connections by others).
7. In the event of loss of 4-20 mA reference signal the drive should give an alarm and maintain last reference (within 10 percent).

E. Inverter duty motors with insulated bearings, winding thermisters and suitable for operation from variable frequency drives.

F. Provide all wiring/circuits required to achieve functionality described in the control drawings, electrical drawings (where applicable) and specifications.

G. CSA certified, suitable for use with Class 1, Zone 1, explosion-proof fan motors supplied with the fans where scheduled.

H. In the "Auto" mode, the fan ramps up to high speed when a remote contact (pushbutton or gas detector) closure is sensed by VFD controls.

I. Output signals to be monitored by DDC control system as follows:
1. Analog (4-20 mA or 0-10 VDC) signal corresponding to fan speed.
2. Digital output (isolated contacts) for VFD fault indication.
3. Digital output (isolated contacts) for VFD run status.
4. Digital output (isolated contacts) for VFD "HAND" selected.
5. Digital output (isolated contacts) for VFD "AUTO" selected.

J. Provide thermistor operated relays.

K. VFD cabinets are to be complete with door interlocked fused disconnect switch.

L. Provide 3 spare fuses of each kind per VFD per unit.

M. VFD integrator or supplier is to provide start up assistance and training to the Owner's (Region) staff.

2.5 MOTORS

A. Except where more stringent requirements indicated in unit Specifications, or equipment schedules, provide manufacturer's standard motor complying with following requirements.

B. Definite Purpose Motors: NEMA MG 1-18.

C. General Purpose, Poly-phase Motors 5 hp and Larger: Comply with Section 26 2000.

D. Single-Phase Motors: Unless otherwise indicated, for motor requirements less than 1/2 hp, provide single-phase motors conforming to following.
   1. Type: Continuous duty, squirrel cage, induction, fractional horsepower motors, rated in accordance with NEMA MG1-10.33.
      a. 1/20 to 1/8 hp: Shaded pole, NEMA N or O as determined appropriate for application by equipment manufacturer.
      b. 1/6 to 1/3 hp: Permanent split capacitor, with internal overload protection, NEMA N or O as determined appropriate for application by equipment manufacturer.
      c. 1/3 hp and larger: 2-valve capacitor, NEMA L, M, N or O as determined appropriate for application by equipment manufacturer.
   2. Enclosure Classification: Open drip-proof machine, NEMA MG-1, unless otherwise indicated.
   3. Insulation Class Rating:
      a. Fractional horsepower motors: Class A.
      b. Integral horsepower motors: Class B.
      c. Definite purpose motors: Class A, B, F or H as determined appropriate for application by equipment manufacturer.

E. Poly-Phase Motors:
   1. Type: Continuous duty; squirrel cage; induction, fractional, and integral horsepower motors; rated in accordance with NEMA MG1-10.33.
      a. 1/3 to 3 hp: NEMA B or C as determined appropriate for application by equipment manufacturer.
      b. Where rated motor loads produce uncorrected motor power factors less than 0.90, provide capacitors for power factor correction to 0.95.
   2. Enclosure Classification: Open drip-proof machine, NEMA MG-1, unless otherwise indicated.
   3. Insulation Class Rating: Suitable for continuous operation in 40□C environment, tested in accordance with IEEE 112 and 114.
      a. Fractional horsepower motors: Class A.
      b. Integral horsepower motors: Class B.
      c. High starting torque motors: Class F.
      d. Definite purpose motors: Class A, B, F or H as determined appropriate for application by equipment manufacturer.

F. Service Factor: Minimum 1.15 for NEMA A, B, and C poly-phase motors, in accordance with NEMA MG 1-12.47 for fractional horsepower motors.

G. Bearings: Permanently lubricated ball or regreasable sleeve bearings with inner and outer shaft seals, designed to resist thrust loading.

H. Efficiency: Provide high efficiency poly-phase motors in accordance with IEEE 112, Test Method B.

I. Provide motors with reserve power to deliver 10% extra air at 20% higher static head without exceeding motor nameplate capacity or operating in motor service factor.

J. Variable Frequency Drive Applications: Provide special purpose, high efficiency motors specifically constructed for use with, and matched to, variable frequency drive. NEMA B, Class F insulation with nonwicking motor leads and copper windings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which fans to be installed. Do not proceed with Work until unsatisfactory conditions corrected.

3.2 INSTALLATION OF CENTRIFGUGAL FANS

A. Install centrifugal fans where indicated in accordance with manufacturer's installation instructions and recognized industry practices to ensure centrifugal fans comply with requirements and serve intended function.

B. Support fans from adjacent walls or structural roof members as required or as indicated on Drawings.

C. Install ceiling exhaust fans where shown on drawings. Secure each fan-housing rigidly in place in the ceiling space.
1. Install fan-motor assemblies and plug into housing receptacles.
2. Install accessories supplied loose.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.
1. Verify electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26. Verify proper rotation direction of fan wheels. Do not proceed with equipment startup until wiring installation acceptable to equipment installer.

E. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

3.3 INSTALLATION OF AXIAL FANS

A. Install axial fans plum and level where indicated in accordance with manufacturer's installation instructions and recognized industry practices, ensuring axial fans comply with requirements and serve intended purposes.

B. Access: Provide access and service space around and over axial fans as indicated, but in no case less than recommended by manufacturer.

C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.

D. Verify electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26. Verify proper rotation in direction indicated and intended for proper performance of axial fans. Do not proceed with equipment startup until wiring installation acceptable to equipment installer.

3.4 FIELD QUALITY CONTROL

A. After installation of fans complete, test each fan to demonstrate proper operation of units at performance requirements specified.

B. When possible, field correct malfunctioning units, then retest to demonstrate compliance.

C. Replace units which cannot be satisfactorily corrected.

3.5 CLEANING

A. Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 3400

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SECTION 23 8146

WATER-SOURCE HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water-source heat pumps.
   2. Packaged controls.

B. Refer to Division 26 for following; not Work of this section.
   1. Power supply wiring from power source to power connection on unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed by manufacturer.

C. Provide following electrical work as Work of this section, complying with requirements of Division 26.
   1. Control wiring between field-installed controls, indicating devices, and unit control panels.

1.2 SUBMITTALS

A. Product Data:
   1. Manufacturer’s technical product data including rated capacities of selected model clearly indicated.
   2. Operating weights.
   3. Furnished specialties and accessories.
   4. Installation, rigging, and start-up instructions.

B. Shop Drawings:
   1. Submit manufacturer’s assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components.
   2. Wiring Diagrams: Submit manufacturer’s electrical requirements for power supply wiring to water-source heat pumps. Submit manufacturer’s ladder-type wiring diagrams for interlock and control wiring required for final installation of water-source heat pumps and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
   3. Submit manufacturer's approved calculations/drawings showing geothermal piping patterns, pressure drop, and areas sufficient to provide required heating/cooling capacities as scheduled.

C. Operating and Maintenance Data (O&M):
   1. Maintenance data and parts list for each water-source heat pump, control, and accessory; including “trouble- shooting” maintenance guide.

D. Submit in accordance with Section 01 3300.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of water-source heat pumps, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Codes and Standards:
   1. ARI/ISO Compliance: Test and rate water-source heat pumps in accordance with ARI Standard 13256-1. Provide ARI/ISO and CUL Certification.
   2. ASHRAE Compliance: Design, construct, and assemble refrigerating system in accordance with ASHRAE 90.1 – 2016.
   3. IECC Compliance: Provide water-source heat pumps with not less than minimum COP/Efficiency levels as prescribed in IECC.
   4. UL Compliance: Design, construct, and assemble water-source heat pumps for use with duct systems so as to meet the safety requirements of UL 1995.
   5. UL Labels: Provide water-source heat pumps that are UL listed and labeled.
   6. National Electrical Code (NEC) Compliance: Install water-source heat pumps in accordance with National Fire Protection Association (NFPA) 70.

1.4 DELIVERY, STORAGE AND HANDLING

A. Handle water-source heat pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged water-source heat pumps or components; replace with new.

B. Store water-source heat pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading water-source heat pumps and moving units to final location for installation.

1.5 WARRANTY

A. Warranty on Motor/Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only and does not include labor for removal and reinstallation.
   1. Warranty Period: 5 yrs from Date of Substantial Completion.

1.6 MAINTENANCE

A. Extra Materials:
   1. 1 set of matched fan belts for each belt driven fan.
   2. 1 set filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Trane (The) Co.
   1. Contact Information:
      Micah Tjeerdsma

Account Manager – Trane Commercial Systems – Great Northern Plains
Work # (920)636-4215
Micah.tjeerdsma@trane.com

B. Water Furnace.

C. Daikin.

D. Or equal.

2.2 WATER-SOURCE HEAT PUMPS

A. Provide factory-assembled and tested packaged water- source heat pumps as indicated, consisting of cabinet; sealed refrigerant circuit including compressor, refrigerant to water heat exchanger, refrigerant to air heat exchanger (coil), and reversing valve; evaporator fans; hot gas by-pass, refrigeration and packaged temperature controls; filters; and dampers. Provide capacities and electrical characteristics as scheduled.

2.3 GENERAL:

A. Casings - Shall be corner post and panel construction with a minimum 16-gauge galvanized steel base pan. Compressor and airside compartment access panels shall be lined internally with acoustic type dual density fibrous glass insulation with edges sealed or tucked under flanges to prevent glass fibers from entering the supply air stream. All construction shall meet the National Fire Protection Association Standard NFPA 90A. All internal sheet metal parts subject to water exposure shall be galvanized or non-ferrous and coated with a baked-on, thermosetting plastic coating. Compressor mounting shall incorporate "double isolation."
1. Panels shall be insulated with ½-in. thick dual density bonded glass fiber. The exposed side is a high density erosion proof material suitable for use in air streams up to 3600 feet per minute. The insulation shall meet requirements of UL 181. It has a flame spread of less than 25 and a smoke developed classification of less than 50 per ASTM E-84 and UL 723.
2. The elastomeric foam shall be UL listed with a flammability rating of UL 94-5V.

B. Horizontal and Vertical Mounted Units – Each heat pump shall incorporate independent access panels to facilitate service and inspection to internal components. Unit shall have an insulated divider panel between compressor compartment and fan blower section. Access panels shall be designed to cover an individual unit section, such as the fan blower, while servicing compressor compartment and related refrigerant components.
1. The unit shall be installed for proper access.
2. Procedures for proper access inspection and cleaning of the unit shall be included in the maintenance manual.

C. Configuration – Units shall be provided configured as shown on the plans, in one of the following air-flow arrangements (Note: "Right" or "Left" side shall be determined when viewing the compressor compartment end panel):
1. Right Hand Return Air and Right-Hand Piping Connections unless shown otherwise on drawings or schedule.

D. Compressor – The unit shall contain a high efficiency rotary or scroll compressor. External vibration isolation shall be provided by rubber mounting devices located underneath the mounting base of the compressor.

1. Internal thermal overload protection shall be provided.
2. High pressure switch shall be provided for protection against excessive discharge pressure.
3. Low pressure switch shall be provided for protection against a loss of charge.

E. Blower - The blower shall be a forward-curved style wheel with multiple speed combinations available. All direct drive motors shall have sealed bearings that do not require field lubrication. The motor has a permanent split capacitor with thermal overload protection. Options of standard static or high static can be selected. The motor contains a quick disconnect plug. They are constructed of corrosion resistant galvanized material. Removal of the motor and fan wheel is made with the assistance of a factory provided orifice ring device. This device attaches the wheel and motor to the fan housing in a single assembly eliminating the need for access to the set screw on the backside of the fan hub.
1. Options of the blower motor/fan packages shall be selected and wired from the factory to match performance criteria scheduled. Fan(s) shall be placed in a draw-through configuration.

F. Electrical – The unit control box shall contain all necessary devices to allow heating and cooling operation to occur from a remote thermostat. These devices shall be as follows:
1. 24 VAC energy limiting class II 50 VA (minimum) transformer.
2. 24 VAV blower motor relay.
3. 24 VAC compressor contactor for compressor control.
4. 24 VAC control valve contactor(s) for 2-way valve and 3-way (diverting) valve control.
5. 24 VAC circulating pump contactor for pump control.
6. Field thermostat connections shall be provided for ease of hook-up to terminal strip located in the unit's control box.
7. Lockout relay which controls cycling of compressor shall be provided to protect the compressor during adverse operating conditions. The device may be reset by interrupting power to the 24 VAC control circuit. Reset may be done either at the remote thermostat or through a momentary main power interruption.

G. Air-to-refrigerant Coil – The air-to-refrigerant coil shall consist of copper tubes mechanically bonded into evenly spaced aluminum fins. All coils shall be leak tested to 450 psig and pressure tested to 650 psig at the factory to ensure the pressure integrity. The tubes to be completely evacuated of air and correctly charged with proper volume of R410A refrigerant prior to shipment.
1. Refrigerant filters furnished for field installation.

The refrigerant coil distributor assembly shall be of orifice style with round copper distributor tubes. The tubes shall be sized consistently with the capacity of the coil. Suction headers shall be fabricated from rounded copper pipe. A thermostatic expansion valve shall be factory selected and installed for a wide range of control.

H. Sound Attenuation Package – Sound attenuation shall be provided as standard feature in the product design. The sound reduction package (0.50 to 5-ton units) shall include vibration isolation to the compressor and water-to refrigerant coil, unit base stiffeners, insulated metal compressor enclosure, and a second stage of vibration isolation to the compressor and water-to-refrigerant base pan.
1. Unit shall be tested and rated in accordance with AHRI 260.

I. Internal Electric Heat – Boilerless control electric heat shall be factory wired and tested. The boilerless control option shall be composed of a nichrome open wire coil designed for approximately 2-kw per unit ton. It shall consist of a single stage of electric heat used as a primary heating source when compressor lockout has occurred due to the entering water temperature falling

below set-point temperature with range of 25°F to 60°F. Once the entering water temperature rises above 60°F, the boilerless controller return the unit to normal operation and locks out the electric heater. All power connections to the electric heat shall be made in the equipment's control box.

1. Electric heating capacity shall be provided as scheduled.

J. Water-to-refrigerant System – The Water-to-Refrigerant heat exchanger shall be constructed from a high-quality coaxial coil for maximum heat transfer. The water side heat exchanger shall be constructed from cupro-nickel and shall be deeply fluted to enhance heat transfer and minimize fouling and scaling. The coil shall have a working pressure of 400 psig on the water side and 650 psig on the refrigerant side.

1. Reversing Valve – The reversing valve is a pilot operating sliding piston type with replaceable encapsulated magnetic coil. This valve is energized in cooling mode.
2. Tubing – The refrigerant tubing shall be of 99% pure copper. The system shall be free from contaminants and conditions such as drilling fragments, dirt, and oil. All water lines that are located in the indoor air stream and refrigerant lines that are located in the indoor air stream that are not directly over the drain pan shall be insulated with 3/8-in. thick elastomeric insulation.

K. Thermostatic Expansion Valve – The unit shall be provided with a bi-directional thermal expansion valve. This device allows operation of the equipment in the range of 25°F to 120°F entering fluid temperatures and 40°F to 95°F entering air temperatures. The equipment operates with one variable (entering water temperature, entering air temperature, cfm, or gpm) at an extreme condition. All other variables must be within the nominal range of operation.

L. Hot Gas Reheat – Dehumidification shall be provided through a hot gas reheat option as scheduled. The coil shall consist of 3/8-in. or ½-in. copper tubes mechanically expanded into evenly spaced aluminum fins. All coils shall be proof and leak tested. The proof test must be performed at 1.5 times the maximum operation pressure and the leak test performed at the maximum operating pressure.

M. Air Section - The air section of the unit shall be isolated from the compressor and control section with an insulated divider panel to minimize the transmission of compressor noise and to permit operational service testing with the compressor compartment cover removed.

N. Filters – A 2-in. MERV 13 filter(s) shall be provided with the unit. A MERV 13 rating requires 90% efficiency on 1-3 micron particles and greater than 90% efficiency on 3-10 micron particles when tested in accordance with ASHRAE Test Standard 52.2.

1. Filter access shall be side removal and easily accessible.

O. Piping Connections - Supply and return raw water piping connections – shall be FPT fittings, brazed copper water tubes and securely flush mounted to the cabinet corner post allowing for connection to a flexible hose without the use of a back-up wrench. Condensate drain connection shall not be less than 3/4" FPT fitting securely flush mounted to the corner post. Supply, return, and condensate drain piping shall be connected and installed as detailed on mechanical drawings.

P. Polymer Drain Pan – The polymer drain pan shall be constructed of polymer material complying with UL94-5V flammability requirements. The bottom of the drain pan shall be sloped on two planes which pitches the condensate to the drain connection, complying with ASHRAE 62 for IAQ conformity.

2.4 CONTROLS

A. Individual Heat Pump Controls – Provide a microprocessor-based control board conveniently located in the control box. The board is unique to water-source products and is designed to control the unit as well as provide outputs for unit status and fault detection. The board is factory wired to a terminal strip to provide all necessary terminals for field connections. Board will include the following points:
   1. 18-pole strip for low voltage field wiring.
   2. For 0.5 to 5 tons, 50 VA transformer.
   3. For 6 to 25 tons, 75 VA transformer.
   4. Anti-short cycle compressor protection.
   5. Brown out protection.
   6. Compressor contactor.
   7. Compressor delay on start.
   8. Compressor lock-out relay.
   9. Condensate overflow.
   10. Electric heat and compressor enable (6 to 25 tons).
   11. Freeze protection.
   12. High pressure switch.
   13. Hot gas reheat.
   14. Low pressure switch.
   15. Low pressure time delay.
   16. Multi-speed fan motor.
   17. Reversing valve coil.
   18. Soft lockout mode.
   19. Random start delay.
   20. Water circulating pump run relay.

B. Provide Heat Pump System Controls as follows:
   1. Trane Tracer UC400 System controller.
   2. Or equal.

C. The system controller can be used in a stand-alone application or as part of a Trane® Integrated Comfort™ System (ICS). The Tracer® UC400 is LonTalk® certified. It is capable of working with and talking to other LonTalk® certified controllers.

D. System controls will provide the following functions:
   1. Compressor Operation - The compressor is cycled on and off to meet heating or cooling zone demands. Units (for 6 to 25 tons, single and dual compressor) use the unit capacity and pulse width modulation (PWM) logic along with minimum on/off timers to determine the compressor's operation. The compressor is controlled ON for longer periods as capacity increases and shorter periods as capacity decreases.
   2. Condensate Overflow - When condensate reaches the trip point, a condensate overflow signal generates a diagnostic which disables the fan, unit water valves (if present), and compressor. The unit will remain in a halted state until the condensation returns to a normal level. At this time, the switch in the drain pan will automatically reset. However, the controller's condensate overflow diagnostic must be manually reset to clear the diagnostic and restart the unit.
   3. Data Sharing - The Tracer® UC400 controller is capable of sending or receiving data (setpoints, fan request, or space temperature) to and from other controllers on the communication link. This allows multiple units to share a common space temperature sensor in both stand-alone and building automation applications.

4. Dehumidification - Dehumidification1 for the water-source heat pump is applicable with the UC400. The controller is capable of directing one stage of DX cooling in conjunction with one stage of reheat (hot gas reheat). Dehumidification can only occur when the controller is in the cooling mode. A humidity sensor is used to measure the zone's relative humidity (RH), then compares the zone relative humidity to the relative humidity enable/disable setpoint parameters. The dehumidification enable and disable points are configurable.
5. Fan Operation - The supply air fan operates at the factory wired speed in the occupied or occupied standby mode. When switch is set to AUTO, the fan is configured for cycling ON with heating or cooling. In heat mode, the fan will run for 30 seconds beyond compressor shutdown in both occupied and unoccupied mode.
6. Filter Maintenance Timer - The controller filter status is based on the unit fan's cumulative run hours. The controller compares the fan run time against an adjustable fan run hours limit and recommends unit maintenance as required.
7. High and Low Pressure Switches - The Tracer® UC400 detects the state of the high pressure or low pressure switches. When a fault is sensed by one of these switches, the corresponding message is sent to the controller to be logged into the fault log. When the circuit returns to normal, the high pressure control and low pressure control automatically reset. If a second fault is detected within a thirty-minute time span, the unit must be manually reset.
8. Occupancy Modes - The four operations of the Tracer® UC400 controller include occupied, occupied standby, occupied bypass and unoccupied:
    a. In an OCCUPIED situation, the controller uses occupied heating and cooling setpoints to provide heating and cooling to the building. This occupied operation is normally used during the daytime hours when the building is at the highest occupancy level.
    b. In an OCCUPIED STANDBY situation, the controllers heating and cooling setpoints are usually wider than the occupied setpoints. This occupied standby operation is used during daytime hours when people are not present in the space (such as lunchtime or recess). To determine the space occupancy, an occupancy sensor is applied.
    c. In an UNOCCUPIED situation, the controller assumes the building is vacant, which normally falls in evening hours when a space may be empty. In the unoccupied mode, the controller uses the default unoccupied heating and cooling setpoints stored in the controller. When the building is in unoccupied mode, individual units may be manually placed into timed override of the unoccupied mode at the units wall sensor. During timed override, the controller interprets the request and initiates the occupied setpoint operation, then reports the effective occupancy mode as occupied bypass.
    d. In the OCCUPIED BYPASS mode, the controller applies the occupied heating and cooling setpoint for a 120-minute time limit.
9. Random Start - To prevent all of the units in a building from energizing major loads at the same time, the controller observes a random start from 0 to 25 seconds. This timer halts the controller until the random start time expires.
10. Reversing Valve Operation - For cooling, the reversing valve output is energized simultaneously with the compressor. It will remain energized until the controller turns on the compressor for heating. At this time, the reversing valve moves to a de-energized state. In the event of a power failure or controller OFF situation, the reversing valve output will default to the heating (de-energized) state.
11. Entering Water Temperature Sampling - The controller will sample the entering water temperature to determine proper control action for units equipped with boilerless electric heat or waterside economizer as scheduled.
12. Waterside Economizer - Entering water temperature (EWT) sampling will automatically occur at power up when the unit is equipped with a waterside economizer (WSE). The EWT is used to determine if economizing is feasible. When the conditions are met, the isolation

valve(s) are driven open for three minutes and the EWT reading is taken. The determination as to whether or not the economizer can be enabled will be made and the controller will take appropriate action. The isolation valve will remain open regardless if the WSE or the DX cooling is enabled. The unit's waterside economizer will contain a 2-position water valve wired to the controller. The economizing water coil will be optimized to provide 100% of the unit capacity at 80.6°F/66.2°F return air temperature with 45°F entering water. The flow rate is established at 86 F entering water temperature and 96°F leaving water temperature. Low leaving air protection will be furnished to protect the unit against delivering air that is cold enough to sweat discharge air grilles. Coil icing protection will also be provided. Waterside economizer cooling will be active during occupied, unoccupied and standby cooling modes.

13. Water Isolation Valve - Variable speed pumping systems are supported by the controller when water isolation valves (12 VA max) are present, up to two isolation valves are supported by the ZN524 controller (one for each compressor circuit). The valves are normally closed unless DX heating, DX cooling, waterside economizer or dehumidification is requested. When the isolation valves are driven open for operation, the outputs will be driven for 20 seconds to ensure adequate water flow before the compressor outputs are energized. Once an isolation valve has been opened, it will remain open for a 10-minute minimum to reduce excessive cycling of the valve.
14. Isolation Valve “ON” Control - The isolation valve output will be energized (controlled open) during compressor heating, compressor cooling, waterside economizing or dehumidification. When the isolation valve is driven open for compressor operation, the output will be energized 20 seconds prior to the compressor and indoor fan (if not already energized) outputs to ensure adequate water flow to the heat exchanger. To reduce excessive cycling of the isolation valve once opened, the isolation valve will remain open for a minimum of 10 minutes.
15. Isolation Valve “OFF” Control - The isolation valve output will be de-energized (controlled closed) when there is no longer a call for compressor or WSE operation and the 10-minute minimum on time has expired.

E. Commercial Touch Screen Programmable Zone Sensor – The Trane® programmable zone sensor is an economical control solution for stand-alone space control applications. Schedule function supports 7-day, 5+2 day, 5+1+1 day schedule options with up to three occupied/unoccupied event pairs per day. The display can be configured to prevent occupant access to temperature setpoints and schedules. Installer password protects configuration and diagnostic screens. Battery free design, all settings and schedules are saved ton non-volatile memory. Settings are maintained through power failure.

F. Auxiliary Relay Output: A 24VAC signal which is turned on when the system control unit is in alarm mode.

G. Warranty - The contractor shall provide one full year warranty for furnishing parts on site which becomes defective in normal operation, from the date of start-up by the manufacturer’s representative, or first beneficial use of the unit. The hermetic motor compressor shall be warranted for an additional four years.

1. Manufacturer’s warranty time periods may or may not coincide with the contractor’s time period of obligation, but where the manufacturer’s warranty contains an expiration date based upon the equipment shipping date, the contractor shall not be relieved of responsibility for covering the full time periods listed above.
2. The contractor shall be responsible for all shipping expenses not included by the manufacturer, both to procure the replacement part, and to return any defective parts to the manufacturer, as they may require.

3. The contractor's replacement warranty obligation after the first year shall be limited to furnishing of replacement parts only and shall not include repair labor costs or materials such as refrigerant, oils, dehydration, refrigerant- moisture dryers, air filters, or drive belts.
4. The owner shall be responsible for providing replacement filters beyond the spares provided in the original contract, and for filter installation labor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which water-source heat pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
1. Install water-source heat pumps in accordance with manufacturer's instructions.
2. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.
1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

C. Connect supply and return ducts to heat pumps with flexible duct connections. Provide transitions to exactly match unit duct connection size.

D. Connect supply and return raw water piping to heat pump as required by manufacturer and as detailed on Mechanical drawings.

E. Condensate Drain Piping: Route condensate drain pipe to floor drain located near water source heat pump or as detailed on Mechanical drawings.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:
1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by OWNER for mandays indicated, travel time excluded, for assistance during plant construction, plant startup, and training of OWNER'S personnel for plant operation. Include:
a. 1/2 manday for Installation Services.
b. 1/2 manday for Instructional Services.
2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas. See Section 01 7500.

B. Start-up water-source heat pumps, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

END OF SECTION 23 8146

SECTION 23 8325

ELECTRIC HEATING TERMINALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fan-forced wall heaters.
   2. Corrosion-resistant (wash down) unit heaters.
   3. Propeller unit heaters.

B. Refer to Division 26 for electrical wiring work required in conjunction with heating terminals; not Work of this section.

1.2 SUBMITTALS

A. Schedule below identifies equipment required for each item of material or equipment.

Terminal Unit Type	Submittal Information Item
Fan-Forced Wall Heaters	1, 2, 3, 4, 5, 6
Propeller Unit Heaters	1, 2, 3, 4, 5, 6
Corrosion-resistant Unit Heaters.	1, 2, 3, 4, 5, 6

B. Submittal Information:
   1. Submit manufacturer's technical product data including rated capacities of selected model clearly indicated, unit weights, furnished specialties and accessories, and installation and startup instructions. Provide gauges, color and finish of materials.
   2. Shop Drawings: Submit manufacture's assembly type Shop Drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components
   3. Wiring Diagrams: Manufacturer's electrical requirements for power supply wiring to terminal units.
   4. Wiring Diagrams: Manufacturer's ladder type for interlock and control wiring. Differentiate between portions of wiring factory-installed and portions to be field-installed.
   5. Motors: For single-phase, definite purpose, special purpose, and general purpose poly-phase motors less than 5 hp, submit NEMA design types, construction, insulation class, NEMA frame size, horsepower, voltage, and amp draw characteristics, and service factor for each common application.
   6. Operating and Maintenance (O&M) Data:
      a. Maintenance instructions including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists.

C. Submit in accordance with Section 01 3300.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical heating terminal units, of types, ratings, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 yrs.

B. Installer: Qualified with at least 3 yrs of successful installation experience on projects with electrical heating terminal installation work similar to that required for Project.

C. Regulatory Requirements:
   1. NFPA Compliance:
      a. Comply with applicable heating terminal installation requirements of NFPA pertaining to installation of space heating equipment and appliances.
      b. Comply with applicable requirements of NFPA No. 90A pertaining to installation of ac systems.
   2. UL Compliance: Comply with applicable requirements of UL 1042. Provide heating terminals UL listed and labeled.
   3. ARI Compliance: Provide fan coil ratings in accordance with ARI 440.
   4. Comply with applicable requirements of SMACNA's "Ducted Electric Heat Guide for Air Handling Systems."
   5. Mining Enforcement and Safety Administration (MESA).

PART 2 - PRODUCTS

2.1 FAN-FORCED WALL HEATERS

A. Manufacturers:
   1. QMark, A Marley Engineered Products Brand.
   2. Berko, A Marley Engineered Products Brand.
   3. Markel Products Company.
   4. Or equal.

B. Except as otherwise indicated, provide electric, fan-forced wall heater manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by the manufacturer, and as required for complete installation.

C. Heating Elements:
   1. Provide elements of indicated duty and rated for indicated capacity, consisting of resistance elements in steel sheath with extended fins or in spiral sheath.
   2. Electric Heating Capacity: Size element for indicated fan speed, cfm, room heating load (Btuh), entering air temperature, and electric input (watts, voltage, phase) as specified on schedule.
   3. Heating elements shall cover entire air discharge area for uniform heating.

D. Back box: Back box shall be designed for duty as recessed rough-in box in either masonry or frame installations and also used with surface mounting frame in surface mounting installations.
   1. Back box shall be constructed of heavy gauge galvanized steel.
   2. Provide knockouts for electrical wiring.

E. Inner Frame Assembly: Heater assembly is mounted inside backbox and consists of heavy gauge steel fan panel upon which is mounted all of operational parts of heater.
   1. Inner frame assembly shall be completely pre-wired.

F. Motors and Controls:
   1. Fan motor shall be impedance protected, permanently lubricated and with totally enclosed motor.

2. Fan control shall be of bi-metallic, snap-action type and shall activated fan after heating element reaches operating temperature and continue to operate fan after thermostat is satisfied and until all heated air has been discharged.
3. Thermostat shall be single pole type.
4. Thermal cutout shall be bi-metallic, snap-action type designed to shut off heat in event of overheating.
5. Fan blade shall be five-bladed and aluminum.

G. Semi-recess Mounting Frame: The semi-recess mounting frame shall be of heavy gauge steel designed to mount around back box for semi-recessed installation.
1. 2-in Semi-recess Mounting Frame, bronze, Model CWHS1AG or equal.
2. Slot knockouts for power supply conduit.

H. Front Cover: Louvered front cover constructed of heavy gauge steel.
1. Plug button to replace thermostat knob and render unit tamper-resistant.

I. Finish: All sheet metal parts, except galvanized steel back box, shall be phosphatized and then completely painted by baked enamel finish selected from manufacturer's standard colors.

2.2 CORROSION-RESISTANT UNIT HEATERS

A. Manufacturers:
1. Industrial Engineering and Equipment Company (INDEECO).
2. QMark, Division of Marley Electric Heating Company.
3. Electromode, Division of Commercial Controls Corporation.
4. Ruffneck Heaters.
5. Or equal.

B. Except as otherwise indicated, provide corrosion-resistant electric unit heater materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

C. Heating Elements:
1. Provide elements rated for indicated capacity, consisting of resistance elements in Monel steel sheath.
2. Electric Heating Capacity: Size elements for indicated fan speed, cfm, room heating load (Btuh), entering air temperature, and electric input (watts, voltage, phase).

D. Casing:
1. Provide removable, epoxy coated steel casings braced and reinforced to provide required stiffness and containing heating element supports. Provide rounded corners. Provide heavy duty, wall-mounted bracket included with unit heater.

E. Air Deflectors: Provide manufacturer’s standard air deflectors of following type.
1. Adjustable horizontal louvers.

F. Motors:
1. Provide epoxy coated, totally enclosed motors, Class B insulation, resiliently mounted, built-in thermal overload protection, sleeve bearings or permanently lubricated ball bearings. Current characteristics: 480 volt, 60 Hz, 3-ph.

2. Internal Wiring: Provide high temperature, heat-resistant wiring with terminal connections protected with heat shrink tubing. Provide wiring and control components in NEMA 4X enclosure. Provide fuses in motor and control circuit wiring.
3. Provide following devices.
    a. Thermally-activated fan switch to keep fan motor operating until residual heat dissipated.
    b. Moisture- and corrosion-resistant, automatic reset, high limit cutout switch.
    c. Moisture and corrosion resistant, UL listed thermostat in NEMA 4X enclosure.
    d. Magnetic contactors for motor and heating elements in NEMA 4X enclosure.

G. Fans: Provide spark proof, epoxy painted propeller fans, statically and dynamically balanced, of indicated capacity.

H. Mounting Bracket: Provide stainless steel swivel mounting bracket which can be used either for wall or ceiling mounting.

2.3 PROPELLER UNIT HEATERS

A. Manufacturers:
1. QMark, Division of Marley Electric Heating Company.
2. Berko Electric Manufacturing.
3. Markel Products Company.
4. Trane Company.
5. Or equal.

B. Except as otherwise indicated, provide manufacturer's standard electric propeller unit heater materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

C. Heating Elements:
1. Provide elements of indicated duty and rated for indicated capacity, consisting of resistance elements in steel sheath with extended fins, or in spiral sheath.
2. Electric Heating Capacity: Size element for indicated fan speed, cfm, room heating load (Btuh), entering air temperature, and electric input (watts, voltage, phase).

D. Casing:
1. General:
    a. Provide casings braced and reinforced to provide required stiffness and containing heating element supports.
    b. Provide rounded corners.
    c. Include fan orifice (Venturi) in casing, as well as threaded hanger connections (weld nuts).
    d. Fabricate from 16 ga steel.

E. Air Deflectors:
1. Provide manufacturer's standard air deflectors.

F. Motors:
1. Provide totally enclosed shaded pole or permanent split capacitor motors, Class B insulation, resiliently mounted, tap wound with built-in thermal overload protection, sleeve bearings or permanently lubricated ball bearings.

2. Internal Wiring: Provide high temperature, heat resistant wiring in flexible metal conduit from terminal junction box to electrical devices. Provide fuses in motor and control circuit wiring.
3. Devices/ Accessories:
    a. Thermally activated fan switch to keep fan motor operating until residual heat dissipated.
    b. Disconnect switch.
    c. Automatic reset, high limit cut-out switch located in discharge air stream.
    d. Magnetic contactor.
    e. Transformer.
    f. Wall-mounted thermostat.
    g. Wall-mounting bracket.

G. Fans:
1. Provide aluminum propeller fans, balanced statically and dynamically of indicated capacity suitable for standard or spark-proof application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install heating terminals as indicated and in accordance with equipment manufacturer's written instructions and recognized industry practices, to ensure heating terminal equipment fulfills requirements. Comply with applicable installation requirements of NEC and NECA's "Standard of Installation."

B. Coordinate with electrical work including wiring/cabling work, as necessary to interface installation of heating terminals with other Work.

C. Clean dust and debris from each heating terminal as installed to ensure cleanliness.

D. Comb out damaged fins where bent or crushed before covering elements with enclosures.

E. Touch up scratched or marred heating terminal enclosure surfaces to match original finishes.

3.2 GROUNDING

A. Provide equipment grounding connections, sufficiently tight to ensure permanent and effective ground for heating terminals as indicated.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:
1. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas. See Section 01 7500.

B. Testing:
1. Upon completion of installation of heating terminals and after building circuitry is energized, test heating terminals to demonstrate capability and compliance with requirements.
2. Where possible, field correct malfunctioning units then retest to demonstrate compliance.

END OF SECTION 23 8325

SECTION 23 8410

DEHUMIDIFIERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's technical product data including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories, electrical characteristics, and installation and startup instructions.
   2. Submit in accordance with Section 01 3300.

B. Operation and Maintenance (O&M) Data:
   1. Maintenance instructions including lubrication instructions, control motor and drive replacement, and spare parts lists.
   2. Submit in accordance with Section 01 3300.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Firms regularly engaged in manufacture of humidifier products of types and sizes indicated on drawings.

B. Requirements of Regulatory Agencies:
   1. Ohio Mechanical Code (2017).
   2. International Energy Conservation Code (2012).
   3. ASHRAE 90.1 (2010).

1.3 DELIVERY, STORAGE AND HANDLING

A. Protect against dirt, water, chemical, and mechanical damage.

1.4 WARRANTIES

A. Equipment shall be certified as to capacity.

B. Replace components without charge if faulty operation or unusual wear occur during guarantee period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Quest Dehumidifiers by Therma-stor Products Inc.

B. Or equal.

2.2 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard material and components, as indicated by published product information, designed and constructed as recommended by manufacturer, and required for complete installation.

2.3 DEHUMIDIFIERS

A. Portable refrigeration type dehumidification unit that passes treated air through condenser coil to reclaim heat. Unit shall be provided with four casters and 6 ft. power cord for easy portable use. Unit shall be provided with condensate hose and internal condensate pump capable of lifting condensate 12 ft.

B. Dehumidification to be complete with automatic controls consisting of humidistat with settings from 20 to 80 percent relative humidity, and “on” and “off” setting.

C. Dehumidifier units shall be of size and capacity shown on schedules or drawings. Provide two set of filters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions under which units to be installed.

B. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION

A. Install units in accordance with manufacturer's written instructions, recognized industry practices, and approved submittals to ensure products serve intended function.

B. Install as indicated on drawings. Route condensate hose to nearest floor or hub drain. Provide ridged metal protective drain covering for section of drain exposed to foot traffic.

3.3 ELECTRICAL CONNECTIONS

A. Electrical installation shall comply with Division 26.

3.4 FIELD QUALITY CONTROL

A. After installation of unit has been completed, test to demonstrate proper operation at performance requirements specified.

B. Correct malfunctioning units, retest to demonstrate compliance.

C. Replace units which cannot be satisfactorily corrected.

END OF SECTION 23 8410

SECTION 26 0505

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to implement the following general administrative and procedural requirements in accordance with the plans and as specified herein.

B. Extent of Work: Work under this contract consists of furnishing, installing, testing, placing into operation, and guaranteeing complete electrical systems, as shown on the drawings and as specified in Division 26. The Contractor shall connect and place all wired equipment in proper working order. Refer to the plans and specifications for work included in this Contract. Some general guidelines to coordinating work between Division 26 and other Divisions are as follows:

1. Division 26 includes all power wiring and raceways for equipment furnished under other Divisions. Motor starters and disconnect switches for Division 23 equipment shall be provided under Division 26 unless otherwise noted. Remote two-wire control logic will be extended to the motor starters as work of Division 23. Where combined line voltage power/control is used for Division 23 equipment, the wiring and raceways are treated as power wiring and are work of Division 26.
2. Division 26 is responsible for providing appropriate wire and conduit between all distribution equipment and all electrical devices and utilization equipment shown on plans. It is also the responsibility of Division 26 to provide all wire, conduit, and devices necessary to accomplish all control functions as indicated by the control diagrams which are not specifically shown as work of another division.
3. Division 26 provides all power wiring and raceways for plant equipment provided under Division 40. Division 26 provides all control, signal, and communication wiring and conduit for the instrumentation and control equipment provided under Division 40

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

1. All work shall be installed in full accordance with the latest edition of the National Electrical Code (NEC) as prepared and published by the National Fire Protection Association (NFPA) and any applicable local or state codes. All electrical equipment shall be listed and labeled by Underwriters' Laboratories, Inc. (UL) or any approved independent nationally recognized electrical testing laboratory where such standards exist. Optionally, in lieu of such listing and labeling, equipment pre-approved by the Electrical Inspector may be supplied. Wherever UL compliance is mentioned in the

specifications, the above alternatives shall be understood to apply to all listing and labeling requirements. This does not preempt or replace the specifications or replace the approval process. All service switches/circuit breakers shall be listed and labeled as outlined above for service entrance duty.

2. Comply with the requirements of NFPA Code 241 "Building Construction and Demolition Operations," the American National Standards Institute (ANSI) A10 Series standards for "Safety Requirements for Construction and Demolition," and the National Electrical Contractors Association (NECA) National Joint Guideline NJG-6 "Temporary Job Utilities and Services."
3. In addition to the requirements outlined under other sections of the Contract Documents, all Work, material, and equipment shall comply with all requirements of the latest editions and interim amendments of the National Electrical Safety Code, National Fire Protection Association, OSHA, the building Owner's insurance company, and all applicable federal, state, and local laws and ordinances. All materials shall be listed and labeled by UL and installed as required by the listing.
4. Should any changes in the Drawings or the Project Manual be required to conform to the above regulations, the Contractor shall notify the Engineer at the time of submitting his bid. After entering into the Owner-Contractor Agreement, the Contractor shall be held to complete all Work necessary to meet these requirements without additional expense to the Owner.

B. Permits and Regulations
1. The Contractor shall obtain all permits and inspections required by laws, ordinances, rules, regulations, and public authority having jurisdiction and shall obtain certificates of such inspections and shall submit same to the Engineer and shall pay all fees, charges, and expenses in connection therewith. The Contractor shall furnish to the Owner a certificate of final inspection from the proper authority prior to final payment. Obtain and pay for easements required to bring temporary utilities to the site, where the Owner's easement cannot be utilized for that purpose.
2. The Contractor shall not allow or cause any of the Work to be covered up or enclosed until the Engineer or Owner has been notified and given reasonable opportunity (2 working days) to review the Work. When required by law or regulations, the governmental agency having jurisdiction for inspections shall be given reasonable notice and opportunity to inspect the Work. Any Work that is enclosed or covered up before such inspection and test shall be uncovered at the Contractor's expense; after it has been inspected, the Contractor shall restore the Work to its original condition at his own expense.

C. Interpretation of Drawings and Project Manual
1. Any discrepancies among Drawings, Project Manual, Drawings and Project Manual, or between Drawings and Project Manual shall be promptly brought to the attention of the Engineer for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Engineer during the bidding period or of any error on the Contractor's part.
2. The locations of switch, receptacle, light, motor, etc., outlets shown on Drawings are approximate. The Contractor shall use good judgment in placing the preceding to eliminate all interference with ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Engineer.

3. Check all door swings so that light switches are not located behind doors. Relocate switches as required, with Engineer's review.
4. All general trades and mechanical Drawings shall be checked by the Contractor before installing any outlets, power wiring, etc.
5. Equipment sizes and locations shown on the Drawings are estimated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements, including wire and conduit entrance locations, and install wire, conduit, disconnect switches, motor starters, overload heaters, circuit breakers, or other items of the correct size and locations for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Engineer.
6. The Contractor shall provide all wiring, including disconnect switches and starters for all electrically operated equipment shown on Drawings, specified or required, except that starters and/or disconnect switches need not be furnished where it is specifically noted that they are furnished with the equipment.
7. The Drawings show the general arrangement required for installation of equipment and materials. The Contractor shall follow these Drawings as closely as possible. Should conditions necessitate other arrangements, the Contractor shall prepare and submit drawings showing the changes to the Engineer for review before proceeding with the Work.
8. The Engineer reserves the right to make minor changes in the location of the installation of equipment and materials up to the time of roughing in at no extra cost to the Owner.
9. The Drawings do not show all offsets and do not detail every point at which unusual conditions of construction may require special attention. All additional fittings, conduits or specialties and other appurtenances necessary due to field conditions shall be provided by the Contractor.
10. In all cases where a device or part of the equipment is herein referred to in the singular, it is intended that such reference shall apply to as many such devices as are required to complete the installations.
11. Wherever in this Division 26 a Manufacturer is specified with the notation “or approved equal," the decision as to the material or equipment being "equal" shall be made by the Engineer, without exception, and this decision shall be accepted by the Contractor as final. Where the Contractor proposes to furnish equipment or material in accordance with the "or approved equal" notation, said equipment or materials shall be submitted to the Engineer for review in accordance with the requirements set forth in the "Substitutions" paragraph of the "Submittals" paragraph of this Section.

1.4 SUBMITTALS

A. Transmittal: Furnish manufacturer's product data, test reports, and materials certifications as required.
   1. Follow the procedures specified in Division 01 Section "Submittal Procedures" and in addition, the Contractor shall prepare and submit a complete submittal list to the Engineer. The submittal list shall include all submittal items covered in the Division 26 specification sections. In addition, the submittal list shall contain dates for all items to be submitted and shall accompany the first submittal. The submittal list shall be coordinated with the construction schedule and shall clearly show such coordination.
   2. Shop Drawings: Shop drawings shall be submitted to the Engineer for approval. Shop drawings shall identify the specific equipment and material being supplied, and all accessories, dimensions, descriptions, mounting and connection details, wiring diagrams,

elementary control diagrams, equipment interface diagrams, and any other information necessary to determine compliance with the plans and specifications. Fabrication and installation shall be in accordance with the approved shop drawings.

3. Permits and Easements: Submit copies of reports, permits, and easements necessary for installation, use, and operation.
4. Test Reports: Submit copies of reports of tests, inspections, and meter readings as specified. Tests, inspections, and meter readings shall be performed using the Contractor's temporary power source unless otherwise specified.

B. Additional copies may be required by individual sections of these specifications.

C. Coordination Drawings

1. Prepare coordination drawings in accordance with Division 01 section "Project Coordination; Bid Package Contracts" to a scale of 1/4 inch = 1 foot–0 inches or larger, detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:
    a. Submit conduit layout drawings showing all conduit sizes, the number and size of each conductor installed in each conduit, and the intended use for each conduit. Drawings should clearly delineate method of conduit installation and should include details of any special conduit support or mounting method. All wiring devices, lighting fixtures, and equipment supplying or requiring electrical power shall be located on the layout drawings. In addition, include the following:
        1) Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
        2) Exterior wall and foundation penetrations.
        3) Fire-rated wall and floor penetrations.
        4) Equipment connections and support details. Demonstrate evidence of dimensional coordination.
        5) Sizes and location of required concrete pads and bases.
    b. Prepare and submit point-to-point interconnection wiring diagrams. The diagrams shall identify all external interconnecting wiring associated with all new and modified existing equipment. The diagrams shall be developed for performance of the Work and to document terminations.
        1) The point-to-point interconnection wiring diagrams shall include:
            a) Wiring and conduit numbers
            b) Terminal strip numbers for each wire termination
            c) Color coding
            d) Raceway and boxes in which wiring is to be located
            e) Location and functional name of items to which wiring is connected.
        2) Use information obtained from approved submittals, record drawings, and field inspections as necessary to complete the diagrams.
    c. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
    d. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

e. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

D. Record Documents: Prepare record documents in accordance with the requirements in Division 01 Section "Closeout Procedures". In addition to the requirements specified in Division 1, indicate installed conditions for:
1. Raceway systems, size, contents, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

E. Operations and Maintenance Manuals
1. Prepare maintenance manuals in accordance with Division 01 Section "Closeout Procedures". Compile and assemble the operation and maintenance data of equipment specified in Division 26 into a separate set of vinyl-covered three-ring binders, tabulated and indexed for easy reference. Data shall clearly indicate all options and accessories.
2. In addition to the requirements specified in Division 1, include the following information for equipment items:
a. Manual index.
b. Manufacturers' descriptive literature.
c. Final signed submittal copy of shop drawings.
d. As-built drawings.
e. Spare parts and replacement parts lists.
f. Manufacturers' maintenance and service manuals.
g. Project-specific description of operation.
h. Wiring diagrams.
i. Manufacturers' guarantee and warranty.
j. Test results.
k. Motor list, including motor description, motor horsepower, motor voltage, fuse size, fuse type, and overload size.
l. Fuse list including fuse location, fuse size, fuse type, and load description.
m. Fixture ballast schedule.
n. Lamp schedule.
3. Materials for more than one item shall clearly indicate which item or items are included on the Project.
4. Shop Drawings which are folded and punched for insertion in the Manual shall be such that the Drawings can be unfolded without removing them from the Manual, and all information shall be legible.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.6 SPECIAL WARRANTY

A. Compile and assemble the warranties specified in Division 26 into a separate set of vinyl-covered three-ring binders, tabulated and indexed for easy reference.

B. Provide complete warranty information for each item. Information to include:
   1. Product or equipment list.
   2. Date of beginning of warranty or bond.
   3. Duration of warranty or bond.
   4. Names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.7 DEFINITIONS

A. Finished locations. The following are defined as finished locations:
   1. Areas with carpet or tile floors.
   2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
   3. Areas with tiled, plastered, or paneled walls.

B. Interior locations. The following are defined as interior locations:
   1. Any location within the boundaries of the foundation of any building.
   2. Any location within the superstructure of other structures not classified as buildings.

C. Wet locations. The following are defined as wet locations:
   1. All exterior locations.
   2. All interior locations below grade.
   3. All interior locations where wet materials are processed, pumped, transported, or stored.

D. Corrosive locations. The following are defined as corrosive locations.
   1. All locations with chemical feed/transfer equipment
   2. All locations with chemical storage tanks
   3. All locations where chemical storage drums are located.

E. Hazardous (classified) locations. The following are defined as hazardous (classified) locations.
   1. All hazardous (classified) locations and their hazard classification are shown.

1.8 FAULT CURRENT, COORDINATION, AND SELECTIVITY STUDY

A. The Contractor shall provide to the Engineer three copies of a written, detailed, documented selective power distribution system report showing fault currents available using log-log graphical representation. The report shall be stamped by a professional Electrical engineer registered in Ohio. The report shall be based upon data compiled by the Contractor from the actual equipment installed. The report must be submitted and approved prior to project closeout. At a minimum, the report shall contain the following:
   1. Overall system description and diagrams.
   2. System selectivity under fault and other overload conditions.
   3. Ground fault system operation and selectivity.
   4. Tabularized ratings and settings of protection devices verified by electrical testing to ensure coordination and selectivity. They shall include all:
      a. Momentary and interrupting ratings.
      b. Relays and shunt trip devices.
      c. Fuses.

d. Circuit breakers.

5. Conclusions and recommendations.

B. Calculated fault currents shall be provided at the secondary of each transformer, at each piece of service equipment, between service equipment and each motor control center, switchboard or switchgear and for at least one feeder/branch circuit for each motor control center, switchboard, or switchgear. They shall include:

1. Equipment and conductor damage curves.
2. Pick-up and time current characteristics.
3. Short circuit data.
4. Detailed description of test procedures.
5. Design calculations.

1.9 SCHEDULING

A. General: It is mandatory that the facility be maintained in operation during construction and that periods of shut-down due to "line changeovers, etc. are held to a minimum. These outages must be scheduled with and have the concurrence of the Engineer and the Owner. Further, it is mandatory that the completion of various stages of the electrical work coincide with the other phases of construction to maintain and permit operation of new installations as construction progresses.

1.10 COORDINATION WITH WORK OF OTHER TRADE CONTRACTORS

A. General

1. Coordinate all requirements of the Work of this Division with other Trade Contractors. Such requirements include, but are not limited to, locations, sizes, anchors, and similar items.
2. Provide all necessary information to other Trade Contractors for such coordination. Such information shall include conforming Shop Drawings, conforming Product Data, and all other required data.
3. This Contractor shall bear all costs for providing affected Work of related Trade Contractor(s) with no change to the Contract Sum or Date of Substantial Completion.

B. Foundations, Bases, Curbs, and Supports

1. Provide and coordinate all requirements for foundations, bases, curbs, and supports with the related Trade Contractor(s).
2. Provide required dimensions, templates, and all required information on anchors, sleeves, and cast-in-place accessories, including dimensions, to the related Trade Contractor(s).

C. Openings, Recesses, and Chases: Coordinate all requirements and locations for openings, recesses, and chases with the related Trade Contractor(s).

D. Final Connections: Coordinate with the related Trade Contractor(s) all requirements for roughing-in and final connections for equipment installed under this Division.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Rough-In
   1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
   2. Refer to equipment specifications in Divisions 02 through 40 for rough-in requirements.

B. Electrical Installations: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
   1. Coordinate electrical systems, equipment, and materials installation with other building components.
   2. Verify all dimensions by taking field measurements.
   3. Coordinate and provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
   4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete or supported from or on other structural components, as they are constructed.
   5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building and equipment which must be placed in service before further construction can take place.
   6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service and place each in proper operating order.
   8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that the work is shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer before final placement.
   9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
   10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
   11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
   12. Wiring for equipment furnished by other Contractors shall be provided as specified under the Electrical Contract based on the equipment rating and motor horsepower as specified in the Contract Documents. If the equipment provided by the General, and Mechanical Contractors has different rating or horsepower, the General and Mechanical Contractors shall provide for any necessary electrical changes to accommodate the equipment furnished at no change in contract price. This Contractor shall verify actual equipment nameplate electrical ratings (voltage, horsepower, amps, etc.) match the specified electrical system being supplied to the equipment. Any discrepancies shall be brought to the attention of the Engineer prior to equipment being connected.

3.2 LOAD BALANCING

A. It shall be the responsibility of the Contractor to balance the loads on the service system, all distribution systems, and all power equipment, so that the variation in amperes per phase readings shall not exceed 5% under normal operating conditions.

B. Special care shall be taken during load balancing to prevent reverse rotation of motors.

C. If, during load balancing, a load is shifted from one phase to another in a color-coded system, the Contractor shall paint or tape the ends of the wire at all outlet points with the proper color code for that phase. Failure to do so shall constitute justifiable grounds to require the Contractor to replace the entire circuit with the proper coded wire at no expense to the Owner or Engineer.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with the following requirements:
   1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
      a. Uncover work to provide for installation of ill timed work.
      b. Remove and replace defective work.
      c. Remove and replace work not conforming to requirements of the Contract Documents.
      d. Remove samples of installed work as specified for testing.
      e. Install equipment and materials in existing structures.
      f. Upon written instructions from the Engineer, uncover and restore work to provide for the Engineer observation of concealed work.
   2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new work. Existing electrical items not indicated to be reused are to be removed.
   3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
   4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
   5. Protection of Installed work. During cutting and patching operations, protect adjacent installations.
   6. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
      a. Refer to Division 1 section "References" for definition of experienced "Installer."
   7. The Contractor shall install his work in such a manner and at such times as shall require a minimum of cutting and patching of the building structure.
   8. Certain areas require this Contractor to remove, add to, or relocate portions of existing Work. It shall be this Contractor's responsibility to remove ceilings, portions of walls, etc., in a manner so that he may install new Work. This Contractor shall then patch, repair and/or replace ceilings, walls etc., to match existing conditions. The above applies to all areas not specifically indicated on Architectural Drawings as Work to be performed by General Trades Contractor(s).
   9. If the Contractor fails to do any required patching or repair any damage resulting from the installation of the electrical Work, such patching or repairing shall be done by the Owner and the cost shall be paid by the Contractor.

3.4 ELECTRICAL DEMOLITION

A. General

1. In general, the notation to remove a piece of equipment as indicated on the Drawings shall be interpreted to also include the removal of all electrical equipment, conduit, wires and appurtenances associated with the equipment. This includes, but is not limited to: all wires and conduit from the motor control center starter to the equipment; and all disconnects, remote switches and starters; all controls, alarms, conduit and instrumentation, both local and remote, and all supports, braces and hangers.
2. Electrical removals also consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panel boards, lighting fixtures, and miscellaneous electrical equipment all as shown, specified, or required to perform the Work.
3. All removals of electrical equipment and appurtenances shall be in complete conformance with the requirements of Division 26.
4. It is the Contractor's responsibility as part of this work to maintain all existing electrical systems including power, lighting, intercommunication and instrumentation in continuous, acceptable operation. It is possible that during the period of construction some wiring may be cut or damaged either accidentally or otherwise. The Contractor shall install and maintain any and all temporary wiring (as approved by the Owner) required to keep all electrical apparatus in acceptable operating condition.
5. As soon as possible, the Contractor shall reinstall cut or damaged circuits in their permanent locations.
6. Where any electrical system component is damaged during work on this project and replaced in accordance with this section, the replaced work shall meet all requirements specified in Division 26 even though the damaged components may not have met the requirements of Division 26 prior to being damaged.
7. Where existing electrically operated equipment is relocated, the power and control wiring and appurtenant devices shall be relocated to accommodate same. Installations and materials shall conform to requirements specified in Division 26.
8. Electrical equipment, conduit, wire, and fixtures shall be relocated as necessary to accommodate installation of new and relocated electrically operated equipment and to accommodate structural alterations to existing facilities such as floors, walls, entrance ways, ducting, process equipment, and piping.
9. All equipment and major lengths of wiring retired and removed shall remain the property of the Owner unless shown or directed otherwise and shall be placed in storage on the site by the Contractor where ordered.
10. Existing Conduit Location
    a. In existing structures at this project, there is electrical conduit embedded in concrete. It shall be the responsibility of the Contractor, under this section, to attempt to locate and mark the existence of any conduit embedded in areas where, as part of this Contract, the concrete is to be drilled or cut into for any purpose.
    b. Contractor shall use every available means possible to attempt to locate existing conduit. Whenever a hole is to be cut into an existing slab, wall, or other structural concrete, that area shall be X-rayed prior to drilling to show the locations of conduits and resteel.

B. Electrical Equipment and Fixtures

1. Remove existing electrical equipment and fixtures where shown or required with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to keep the integrity of the grounding systems.

C. Switchboards
   1. Remove and modify distribution switchboards as shown.
   2. Disconnect and dismantle switchboards that are to be removed and dispose of all components off the site.
   3. Remove circuit breakers and other control equipment that will no longer be used from modified switchboards unless otherwise shown or specified.
   4. Cut square all new openings into the modified switchboard panels and dress smooth to the dimensions required for the installation of the new equipment.

D. Motors
   1. Disconnect and remove motors where shown or specified.
   2. Remove from the site motors not designated to remain the property of the Owner.
   3. Store in an enclosed, heated storage area motors or other electrical gear designated for reuse.

E. Conduit and Wire
   1. Remove conduits and wires where shown, or associated with equipment being removed.
   2. Cut abandoned conduits in floor or ceiling slabs, or in walls, flush with the slab or wall at the point of entrance. Plug the conduit suitably and repair the area in a flush, smooth, approved manner.
   3. Disassemble and remove from the site exposed conduits and their supports.
   4. Repair all areas of work to prevent rust spots on exposed surfaces.
   5. Dispose of all removed wire, conduits, supports, and appurtenances.

F. Underground Ducts
   1. Remove wiring in the underground duct system where shown or otherwise required.
   2. Verify the function of all wiring before disconnecting and removing it.
   3. Plug ducts which are not to be reused, where they enter buildings and make watertight.

G. Direct-Burial Cable
   1. Abandon direct-burial cable where shown.
   2. Disconnect such cable at both ends of the run.
   3. Cut back the cable to the point of entrance of a building or structure.
   4. Patch and make watertight all openings in buildings for entrance of abandoned direct-burial cable.

H. Overhead Wiring
   1. Abandon poles and overhead wiring as shown and specified.
   2. Existing substation and poles owned by the local electric utility company will be removed by the local electric utility company.
   3. Remove completely from the site abandoned poles not owned by the local electric utility company.
   4. Perform this work after the new service has been completed and energized, and in accordance with the approved schedule.

5. Make all the necessary arrangements with the local electric utility company for the removal of their transformers and metering equipment after the new electrical system has been installed and energized.

I. Lighting Fixtures
   1. Carefully remove and relocate lighting fixtures as shown on the Drawings.
   2. Remove fixtures from the project site that are not shown to be relocated.

J. Panelboards
   1. Remove panelboards where shown and dispose of off the project site.
   2. Perform all cutting and patching necessary for the removal and replacement of panelboards.

K. Miscellaneous Electrical Equipment
   1. Remove wall switches, receptacles, starters, and other miscellaneous electrical equipment as required and dispose of off the project site.
   2. Remove all equipment with care so as to minimize damage to architectural and structural members. Repair any damage incurred as herein specified.

3.5 CLEANING

A. General: When all work is completed and has been tested and accepted by the Engineer, the Contractor shall clean all light fixtures, equipment, and exposed surfaces that have been directly affected by this work. The Contractor, insofar as the work is concerned, shall at all times keep the premises in a neat and orderly condition and at the completion of the work shall properly clean up and remove any excess materials from the site.

END OF SECTION 26 0505

SECTION 26 0510

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to provide basic electrical materials in accordance with the plans and as specified herein.

B. This section includes limited scope general construction materials and methods for application with electrical installations as follows:
   1. Excavation for underground utilities and services, including underground raceways, vaults, and equipment.
   2. Miscellaneous metals for support of electrical materials and equipment.
   3. Nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
   4. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
   5. Concrete used for the following:
      a. Housekeeping pads.
      b. Pipe supports.
      c. Filling in boxouts in floor slabs, after conduit installation.
      d. Pole foundations.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with basic electrical materials in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein. Where provisions of the pertinent codes and standards conflict with this specification, the more stringent provision shall govern.
   1. American Institute of Steel Construction (AISC) "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings."
   2. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
   3. National Electrical Code (NEC).

B. Qualifications
   1. Installer Qualifications. Engage an experienced Installer for the installation and application of joint sealers.
   2. Qualify welding processes and welding operators in accordance with American Welding Society (AWS) D1.1 "Structural Welding Code -Steel."
      a. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submit the following in accordance with Conditions of Contract and Division 01 specification sections.
   1. Product data for joint sealers.
   2. Shop drawings detailing fabrication and installation for metal fabrications and wood supports and anchorage for electrical materials and equipment.
   3. Samples of joint sealer, consisting of strips of actual products showing full range of colors available for each product.
   4. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this section.

1.5 JOB CONDITIONS

A. Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle joint sealer materials in compliance with the manufacturer's recommendations to prevent their deterioration and damage.

1.7 DEFINITIONS

A. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation at the direction of the Engineer until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

B. Subbase as used in this section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

C. Subgrade as used in this section refers to the compacted soil immediately below the slab or pavement system.

D. Unauthorized excavation as used in this section consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil Materials: Provide soil materials as specified in Division 31 - Earthwork.

B. Miscellaneous Metals and Reinforcing Materials
   1. Provide steel plates, shapes, bars, and bar grating conforming to ASTM A 36.
   2. Provide cold-formed steel tubing conforming to ASTM A 500.
   3. Provide hot-rolled steel tubing conforming to ASTM A 501.
   4. Provide steel pipe conforming to ASTM A 53, Schedule 40, welded.
   5. Provide non-shrink, non-metallic grout which is pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout, recommended for interior and exterior applications.
   6. Provide fasteners which are zinc-coated, type, grade, and class as required.
   7. Provide deformed reinforcing bars conforming to ASTM A615, Grade 40 or 60, unless otherwise indicated.
   8. Provide reinforcing materials with size and placement as shown on the plans.
   9. Provide welded wire fabric conforming to ASTM A185.

C. Miscellaneous Lumber
   1. Provide framing materials that are Standard Grade, light framing size lumber of any species. Number 3 Common or Standard Grade boards complying with West Coast Lumber Inspection Bureau (WCLIB) or American Wood Preservers Association (AWPA) rules, or Number 3 boards complying with Southern Pine Inspection Bureau (SPIB) rules. Lumber shall be preservative treated in accordance with AWPA LP-2, and kiln dried to a moisture content of not more than 19 percent.
   2. Provide construction panels which are plywood panels; American Plywood Association (APA) C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inch.

D. Joint Sealers
   1. Provide joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
   2. Provide colors as selected by the Engineer from manufacturer's standard colors.
   3. Provide the following types of elastomeric joint sealers:
      a. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates, formulated with fungicide, intended for sealing interior joints with non-porous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
   4. Provide fire-resistant watertight joint sealers which are two-part, foamed-in-place, silicone sealant formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by UL, or other testing and inspection agency acceptable to authorities having jurisdiction. Material shall be a closed-cell, non-adhering material.

E. Concrete: Provide concrete as specified in Division 03 - Concrete.

2.2 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
   1. One Part, Mildew-Resistant, Silicone Sealant
      a. "Dow Corning 786," Dow Corning Corp.

b. "SCS 1702 Sanitary," General Electric Co.
c. "863 #345 White," Pecora Corp.
d. "Proglaze White," Tremco Corp.
e. "OmniPlus," Sonneborn Building Products Div.

2. Fire Resistant Joint Sealers
   a. "Dow Corning Fire Stop Foam," Dow Corning Corp.
   b. "Pensil 851," General Electric Co.

PART 3 - EXECUTION

3.1 COORDINATION

A. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Field-verify all locations and dimensions to ensure that the equipment will be properly located, readily accessible, and installed in accordance with all pertinent codes and regulations, the contract documents, and the referenced standards.

C. The work shall be carefully laid out in advance, and where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary for proper installation, this work shall be carefully done, and any drainage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.

D. In the event any discrepancies are discovered, immediately notify the Engineer in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 PREPARATION

A. Preparation for Joint Sealers
   1. Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
   2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.3 EXCAVATION

A. Comply with the applicable requirements of Division 31 - Sitework.

B. For the excavation of underground vaults and electrical structures conform to elevations and dimensions shown within a tolerance of +0.10 foot and extending a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
   1. Excavate, by hand, area within drip line or large trees. Protect the root system from drainage and drying out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
   2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement or precast concrete is placed.

C. Excavate trenches for electrical installation as follows:
   1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
   2. Excavate trenches to depth indicated or required.
   3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
   4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.

D. Backfill excavations as promptly as work permits, but not until completion of the following:
   1. Inspection, testing, approval, and locations of underground utilities have been recorded.
   2. Removal of concrete formwork.
   3. Removal of shoring and bracing, and backfilling of voids.
   4. Removal of trash and debris.

E. Where subsidence occurs at electrical installation excavation during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.4 INSTALLATION

A. Erection of Metal Supports and Anchorage
   1. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
   2. Provide field welding which complies with AWS "Structural Welding Code."

B. Erection of Wood Supports and Anchorage
   1. Cut, fit, and place nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
   2. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
   3. Attach to substrates as required to support applied loads.

C. Application of Joint Sealers
   1. Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
   2. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
   3. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
   4. Install firestopping sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire stops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency. Use dams to obtain proper sealing.

D. Installation of Housekeeping Pads

1. Strength, spacing, and placement of equipment housekeeping pads. Provide a housekeeping pad for all floor-mounted equipment, unless noted otherwise. Fabricate pad as follows:
    a. Coordinate size of housekeeping pad with actual equipment provided. Fabricate base 4 inches larger in both directions than the overall dimensions of the supported equipment.
    b. Form concrete pads with framing lumber treated with form release compounds. Provide 1 inch chamfer on top edge and corners of pad.
    c. Install reinforcing bars and place anchor bolts and sleeves to facilitate securing equipment.

END OF SECTION 26 0510

SECTION 26 0519

WIRES, CABLES, AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install wires, cables, and connectors in accordance with the plans and as specified herein.

B. Miscellaneous: This section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with wires, cables, and connectors in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. National Fire Protection Association (NFPA) 70, National Electrical Code (NEC).
   2. Underwriters' Laboratories, Inc. (UL) Compliance. Provide components which are listed and labeled by UL under the following standards.
      a. UL Standard 83Thermoplastic Insulated Wires and Cables.
      b. UL Standard 486AWire Connectors and Soldering Lugs for Use with Copper Conductors.
      c. UL Standard 854 Service Entrance Cable.
   3. National Electrical Manufacturers Association/lnsulated Cable Engineers Association (NEMA/ICEA) Compliance. Provide components which comply with the following standards:
      a. WC-5 Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      b. WC-7 Cross-Linked Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      c. WC-8 Ethylene Propylene Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   4. Institute of Electrical and Electronic Engineers (IEEE) Compliance. Provide components which comply with the following standards:
      a. Standard 82 Test Procedure for Impulse Voltage Tests on Insulated Conductors.

B. Regulatory Requirements: Comply with provisions of the following code and conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submittals: Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for electrical wires, cables, and connectors.
   2. Product data for Megger insulation testing instrument.
   3. Report sheets for Megger testing.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable properly packaged in factory-fabricated-type containers, or wound on NEMA specified type wire and cable reels.

B. Store wire and cable in clean, dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing, and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wires and Cables
   1. Provide electrical wires and cables of manufacturer's standard materials as indicated by published product information designed and constructed as recommended by manufacturer for a complete installation, and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20 deg C (68 deg F).
   2. Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following UL types those wires with construction features which fulfill project requirements:
      a. Provide Type RHW for dry and wet locations, maximum operating temperature 75 deg C (167 deg F). Insulation, moisture and heat-resistant cross-linked polyethylene; outer covering, moisture-resistant, flame-retardant, non-metallic covering; conductor, annealed copper, Class B stranding.
      b. Provide Type XHHW for dry locations, maximum operating temperature 90 deg C (194 deg F). Insulation, flame-retardant, cross-linked polyethylene; conductor, annealed copper, Class B stranding.
      c. Provide Type THW for dry and wet locations; maximum operating temperature 75 deg C (167 deg F). Insulation, moisture and heat-resistant, flame-retardant thermoplastic; conductor, annealed copper, Class B stranding.

d. Provide Type THWN/THHN for dry and wet locations; maximum operating temperature 75 deg C (167 deg F). Insulation, moisture and heat-resistant, flame-retardant thermoplastic; conductor, annealed copper, Class C stranding.
e. Provide Type MTW for dry locations, maximum operating temperature 90 deg C (167 deg F). Insulation, flame-retardant, moisture, heat and oil-resistant thermoplastic, Class C stranding.

3. VFD Cable
   a. General
      1) UL 1277, UL 1581.
      2) Flexible multi-conductor motor supply cable.
      3) 100% Overall foil or tape shield, drain wire, and PVC jacket.
      4) Bare uncoated copper ground conductor.
      5) Rated 1000VAC / 2000VAC Peak.
   b. Conductors
      1) ASTM B8/B33.
      2) Tinned copper conductors.
      3) Class C stranding.
   c. Insulation: Flame-retardant, moisture-resistant thermoset (XLP) insulation.
   d. Conductor Types: Type XHHW conductors, 1000-Volt, 90 deg C, wet or dry locations, UL 44.
4. Provide color coding for phase identification in accordance with requirements in Division 26 Section "Electrical Identification".

B. Connectors and Terminals
1. General: Provide UL-type factory-fabricated metal connectors and terminals of sizes, ampacity ratings, materials, types, and classes indicated.
2. Twist-on Connectors: Conforming to UL 486 C, consisting of a tapered spring with insulated outer covering.
3. Compression Connectors: Tin-plated copper. Configuration shall be tee, in-line, etc., as required.
4. Terminals: Tin-plated copper, compression locking fork tongue with insulated barrel.
5. Compression Lugs: Tin-plated copper, standard barrel, one-hole or two-hole as required.
6. Heat-Shrink Insulation: Heat-shrinkable polyolefin with an internally applied adhesive watertight sealant.
7. Motor Connection Kit: Consisting of compression lugs bolted together, cloth tape cover, and heat-shrink insulation.
8. Splice Kit: Consisting of compression connector and heat-shrink insulation.

C. Wire and Cable Accessories
1. Tapes and Insulating Materials
   a. Designed for use as electrical insulating tape.
   b. Plastic Tape: Vinyl, 7 mil, 3/4-inch wide, -15 to 100 deg C, UL 510.
   c. Rubber Tapes: Self-fusing, corona-resistant, compatible with specified insulations, minimum dielectric strength of 800 V per mil, 0 to 90 ^{0}C.
   d. Arc-Proofing: Thirty mil, up to 3-inches wide, rated for a 200-amp arc for 30 seconds.
   e. Heat Shrink Insulation: Heat shrinkable polyolefin, internal adhesive sealant, UL 486D.
2. Hardware
   a. General: Carbon steel, cadmium plated.
   b. Bolts: ASTM 449, hex-head, SAE Grade 5, UNC, Class 2B threads.

c. Nuts: ASME B18.2.2, hexagon, SAE Grade 5, UNC, Class 2B threads.
d. Flat Washers: ASME B18.22.1; type A plain, wide-series.
e. Compression (Belleville) Washers: Conical type washer, 0.0005-in.-thick.

3. Wire-Pulling Lubricant
a. Listed by Underwriters Laboratories.
b. Biodegradable, non-flammable, and non-toxic.
c. Solid residue of not more than 1.5 percent and a viscosity of at least 50,000 C.P.S.
d. Compatible with conductor insulation per IEEE 1210.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Wire and Cable
a. American Insulated Wire Corp.
b. Brintec Corp.
c. Carol Cable Co., Inc.
d. Senator Wire and Cable Co.
e. Southwire Company.

2. Connectors and Terminals for Wires and Cable Conductors
a. AMP.
b. Burndy Corporation.
c. Ideal Industries, Inc.
d. 3M Company.
e. O-Z/Gedney Co.
f. Raychem.
g. Thomas and Betts Corp.

3. Tapes and Insulating Materials
a. Okonite Company
b. Plymouth Rubber Company
c. Raychem
d. 3M Company
e. Tyco Corporation, AMP products

4. Wire-Pulling Lubricant
a. Polywater J.
b. High Performance Cable Lubricant.
c. Ideal.
d. Aqua-Jel 2.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION

A. Uses Permitted

1. Install UL Type USE cable for all conductors provided between utility transformers and service entrance rated equipment.
2. Install UL Type RHW or XHHW cable for power feeders, motor branch circuits, panelboard feeder circuits, and below grade or exterior control and metering circuits.
3. Install UL Type THWN/THHN, THW, or XHHW wiring in conduit, for branch circuits for lighting, receptacles, and interior control and metering circuits.

4. Install UL Type MTW wiring interior to instrument and control panels. Conductors shall be stranded with at least 19 strands in the conductor.
5. Install VFD Cable for all branch circuits of VFD controlled equipment.

B. Install electrical cables, wires, and connectors in compliance with NEC.

C. Coordinate cable installation with other work.

D. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL-listed pulling compound or lubricant, where necessary.

E. Use pulling means, including fish tape, cable, rope, and basketweave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

F. Conceal all cable in finished spaces.

G. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible.

H. Power conductors shall be No. 12 AWG minimum. Control conductors may be No. 14 AWG where circuit amperes and the NEC allow and when length does not pose a voltage drop problem.

I. Conductors shall be sized such that voltage drop does not exceed 3% for branch circuits or 5% for feeder/branch circuit combination.

J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

K. Provide connectors, splices, or lugs as required for all oversized conductors due to voltage drop.

3.2 CONNECTOR, TERMINAL, AND SPLICE INSTALLATION

A. Uses Permitted
1. Install twist-on connectors for lighting, communication, and receptacle branch circuits and utilization equipment only in size No. 8 AWG and smaller and only in finished areas.
2. Install forked-tongue terminals on control and metering conductors which connect to terminal blocks.
3. Install motor connection kits on all polyphase induction motors.
4. Install compression connectors and lugs for all other connections.

B. Use splice and tap connectors which are compatible with conductor material.

C. Install all compression connectors, splices, and lugs with a racheting tool which will not release until proper compression is achieved.

D. Install splices which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.

E. Service entrance conductors shall be installed without splices. Electrical equipment feeders shall be spliced only where shown or specifically approved. Control and metering conductors shall be installed without splices.

F. All splices shall be made only by specific permission of the A/E, and then only in manholes or pullboxes, and shall be sealed watertight with a heat-shrink insulation.

G. Tighten electrical connectors and terminals in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

3.3 FIELD QUALITY CONTROL

A. The Contractor shall test each electrical circuit after permanent cables are in place with terminators installed, but before cable or wire is connected to equipment or devices to demonstrate that each circuit is free from improper grounds and short circuits.

B. The Contractor shall test by Megger Test, the insulation resistance between phases and from each phase to ground for each of the following feeder and motor branch circuits:
1. Motor Control Center.
2. Panelboard.
3. Switchboards.
4. Switchgear.
5. Motors.

C. The Megger Testing shall be witnessed by the A/E. The A/E shall be notified at least 48 hours in advance of testing.

D. Measure the insulation resistance at 500 volts dc with a hand-cranked or motor-driven "Megger" insulation testing instrument. Battery-operated test instruments are not permitted. All test instruments are to be provided by the Contractor.

E. If any insulation resistance measures less than 50 megohms, the cable shall be considered faulty with the cable failing the insulation test. In moist environments, bag the ends of the cable to prevent a faulty Megger test.

F. Any cable which fails the insulation tests or which fails when tested under full load conditions shall be replaced with new cable for the full length and retested. Corrective action and repeated tests shall be accomplished at the Contractor's own expense.

G. Maintain testing report sheets identifying each cable tested, what each feeder or motor branch circuit will be connected to, and the level of insulation resistance measured. Test reports shall be signed by the tester, initialed by the A/E and sent to the A/E within 48 hours.

END OF SECTION 26 0519

SECTION 26 0523

SIGNAL AND COMMUNICATION CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this section.

B. Related Sections: The following sections contain requirements that relate to this section:
   1. Division 26 Section “Basic Electrical Requirements”.
   2. Division 26 Section “Basic Electrical Materials and Methods”.
   3. Division 26 Section “Wires and Cables”.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install communication and signal cables in accordance with the plans and as specified herein.

B. Cables and Accessories: This section includes cables and connectors designed for and used in communication, control, data, and signal circuits.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

B. Connected Equipment Manufacturer Approval: Where cables specified in this section are used to provide signal paths for systems specified in other sections of these specifications or for systems furnished under other contracts, obtain review of the cable characteristics and approval for use with the connected system equipment by the connected equipment manufacturers.

C. Electrical Component Standard: Provide work complying with applicable requirements of National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."

D. Toxicity: Comply with applicable codes and regulations regarding toxicity of combustion products of materials used in communication and signal cables.

E. National Electrical Manufacturer's Association/Insulated Cable Engineers Association (NEMA/ICEA) Compliance: Comply with NEMA/ICEA Standard Publication WC 5, "Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy"; WC 30, "Color Coding of Wires and Cables," pertaining to signal transmission cable; and WC 41, "Coaxial Communication Cable."

F. American Society for Testing and Materials (ASTM) Compliance: Comply with applicable requirements of ASTM B 1, B 2, B 3, B 8, B 33, D 2219, and D 2220. Provide copper conductors with conductivity of not less than 98 percent at 20 deg C (68 deg F).

G. Underwriters' Laboratories, Inc. (UL) Compliance: Comply with applicable requirements of UL Standard 83, "Thermoplastic Wires and Cables"; UL 486 A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors"; and UL 910, "Test Method for Fire and Smoke Characteristics of Cables Used in Air Handling Spaces." Provide products that are UL listed and labeled.

H. Electronic Industries Association (EIA) Compliance: Comply with EIA Standards EIA-230, "Color Marking of Thermoplastic Wire," EIA-258, "Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms," and TIA/EIA-568A, "Commercial Building Telecommunications Cabling Standard."

I. MIL-SPEC Compliance: Comply with MIL-C-3093, "Telephone Cable; Inside Distribution Wiring," MIL-C-55021, "Twisted-Pair and Triplet Cables; Hookups General Specifications," MIL-C-17/28, "Radio Frequency Flexible Coaxial Cables, 50 Ohms," and MIL-C-17/29, "Radio Frequency Flexible Coaxial Cables, 75 Ohms."

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and material certifications as required.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cable properly packaged in factory fabricated type containers, or wound on NEMA specified type wire and cable reels.

B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing, and tearing wire, cable insulation, and sheathing. Ensure that dielectric resistance and characteristic impedance integrity of the cable are maintained.

PART 2 - PRODUCTS

2.1 SHIELDED TWISTED PAIR CABLES

A. 600 Volt Rated Shielded Twisted Pair or Triplet Cables: Shielded twisted pair or triplet cable, 16 AWG stranded tinned copper conductors, polyethylene insulation, aluminum tape shield, 18 AWG tinned copper drain wire, UV stabilized PVC jacket, 100 percent shield coverage. Suitable for direct burial. Multiple pair cables shall have an overall shield and an overall PVC jacket.

2.2 CONTROL NETWORK CABLES

A. Ethernet: Four pair, unshielded, Category 6, 24 AWG, stranded copper with PVC insulation and PVC jacket. Cable shall be UL listed.

B. Fiber-Optic:

1. Multimode graded index, tight-buffered, optical glass fiber cores cable:
    a. Compatible with LED-based transmission system and suitable for fiber optic Ethernet LAN standards including point-to-point Fiber Optic Inter-Repeater Link (FOIRL) network, and ANSI standard Fiber Distribution Data Interface (FDDI) networks.
    b. Do not use cable with plastic fiber core construction.
    c. The number of cables and the number of fibers in each cable shall be as specified herein and as shown on the Drawings.
    d. Splitter Kits: The cable shall be provided with the necessary number of splitter kits to accommodate the number of terminations shown for each interconnection box on the Drawings.
    e. Cable shall be assembled with inner strength members, polyester core separator tape, Aramid yarn or similar strength members.
    f. Jackets: Inner PVC jacket with rip cord, and polyethylene outer jacket rip cord. Provide a cable outer jacket that is UV inhibited, fungus resistant and flame retardant.
    g. Attenuation losses: Shall be 3.5 dB/km or less at a wavelength of 850 nm and 1.0 dB/km or less at a wavelength of 1300 nm.
    h. Bandwidth: Minimum bandwidth shall be 160 MHz-km at 850 nm and 500 MHz-km at 1300 nm.
    i. Provide cable unaffected by continuous or intermittent submergence in water, damage from lightning strikes. Shall be resistant to fuel, petro-chemicals and other caustic or noxious materials.
    j. Cable shall be suitable for indoor and outdoor use conduit installation.
    k. Provide continuous inter- and intra- building installation, closet to closet, suitable for passing through inside conduit locations directly from outside conduit.
    l. Cable shall be UL listed as type OFN per NEC 770-51 and NEC 770-53.
    m. Cable specifications are as follows:
        1) Fiber Size: 62.5 micron/125 micron (core/cladding)
        2) Fiber Count: 12 fibers
        3) Nominal Cable Diameter: 0.256 inches
        4) Nominal Cable Weight: 33 pounds per 1000 ft
        5) Crush Resistance: 500 pounds per inch
        6) Maximum Tensile Load: 600 pounds (installation)
        7) Maximum Tensile Load: 135 pounds (in-service)
        8) Minimum Bend Radius: 5.1 inches (installation)
        9) Minimum Bend Radius: 2.6 inches (in-service)
        10) Operating Temperature: -40 to 80degC (core/cadding)
        11) Guaranteed to achieve 300/550 meters at 850/1300 nm for Gigabit Ethernet (IEEE 802.3z) standard-compliant links.
2. Single mode, tight-buffered, optical glass fiber cores cable:
    a. Compatible with laser-based transmission system and suitable for fiber optic Ethernet LAN standards including point-to-point Fiber Optic Inter-Repeater Link (FOIRL) network, and ANSI standard Fiber Distribution Data Interface (FDDI) networks.
    b. Do not use cable with plastic fiber core construction.
    c. The number of cables and the number of fibers in each cable shall be as specified herein and as shown on the Drawings.

d. Splitter Kits: The cable shall be provided with the necessary number of splitter kits to accommodate the number of terminations shown for each interconnection box on the Drawings.
e. Cable shall be assembled with inner strength members, polyester core separator tape, Aramid yarn or similar strength members.
f. Jackets: Inner PVC jacket with rip cord, and polyethylene outer jacket rip cord. Provide a cable outer jacket that is UV inhibited, fungus resistant and flame retardant.
g. Attenuation losses: Shall be 0.5 dB/km or less at a wavelength of 1310 nm and 0.4 dB/km or less at a wavelength of 1550 nm.
h. Provide cable unaffected by continuous or intermittent submergence in water, damage from lightning strikes.
i. Cable shall be suitable for indoor and outdoor use conduit installation.
j. Cable shall be UL listed as type OFN per NEC 770-51 and NEC 770-53.
k. Cable specifications are as follows:
    1) Fiber Size: 8.3 micron/125 micron (core/cladding)
    2) Fiber Count: 12 fibers
    3) Nominal Cable Diameter: 0.256 inches
    4) Nominal Cable Weight: 33 pounds per 1000 ft
    5) Crush Resistance: 500 pounds per inch
    6) Maximum Tensile Load: 600 pounds (installation)
    7) Maximum Tensile Load: 135 pounds (in-service)
    8) Minimum Bend Radius: 5.1 inches (installation)
    9) Minimum Bend Radius: 2.6 inches (in-service)
    10) Operating Temperature: -40 to 80degC (core/cadding)

2.3 CONNECTORS AND TERMINALS

A. Shielded Twisted Pair:
1. Provide terminals as specified in Division 26 Section "Wires, Cables, and Connectors."

B. Ethernet Cable:
1. Provide RJ45 plug at each end.

C. Fiber-Optic Cable:
1. Furnish connect micron core/claddings and components and use specific tools and methods as recommended by the connector manufacturer to form a complete connector system.
2. Provide fiber optic SC simplex connectors; multimode and single mode versions to match cable type. Connectors shall be polymer body with a precision zirconia ferrules.
    a. Connector Specifications
        1) Insertion Loss: 0.15/0.30 dB (typical/maximum)
        2) Durability Delta: 0.1 dB (1000 matings)
        3) Operating Temperature: -40 to +80°C
        4) Cable Retention: 40 pounds
3. Splicing/Splitting
    a. Contractor shall field splice each fiber to a pigtail cable at the termination enclosures. All splices shall be made by the fusion process and shall have a splice loss no greater than 0.35 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each splice. Splice testing shall

be witnessed by the Owner's project representative. Prior to stripping the cable, Contractor shall record the cable length from the cable jacket. This length shall be documented and included in the test documentation.

2.4 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering control/signal cabling products that may be incorporated in the work include but are not limited to the following:

B. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   1. Cables.
      a. Alpha Communications.
      b. American Insulated Wire Corp.
      c. AT&T Network Systems.
      d. Belden Div; Cooper Industries.
      e. Berk-Tek Company.
      f. Cable Continental Cables Co.
      g. Furon Dekoron Division.
      h. Guardian Products Division, General Cable Corporation.
      i. Mohawk Wire & Cable Corp.
      j. Phelps Dodge Cable and Wire Co.
      k. Pirelli Cable Corp.
   2. Connectors.
      a. Thomas & Betts Corporation.
      b. 3M Company.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which communication and signal cables are to be installed. Notify Engineer/Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer/Architect.

3.2 COORDINATION

A. Coordinate with other work, including wires/cables, boxes, and raceways, as necessary to interface installations of communication and signal cables with other work.

3.3 APPLICATIONS

A. Use 300 volt rated single or multiple pair signal cables for all analog dc signals (4-20 mA, 1-5 volt, etc.).

B. Use Ethernet cable for all telephone lines.

C. Use Ethernet cable for all control network connections, unless noted otherwise on the Drawings.

3.4 INSTALLATION

A. General: Install communication and signal cables in accordance with manufacturer's written instructions, in compliance with NEC, and in accordance with standard industry practice.

B. Coordinate installation with other work.

C. Install communication and signal cables without damaging conductors, shield, or jacket. Do not either in handling or installation bend cable to smaller radii than minimum recommended by manufacturer. Ensure that medium manufacturer's recommended pulling tensions are not exceeded. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cable or raceway.

D. Install all cables in conduit.

E. Splices are allowed only at indicated splice points. Where splices are indicated, use splice and tap connectors that are compatible with media material.

F. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published instructions for torque tightening values.

G. Cable Terminations: Terminate cables on numbered terminal blocks where cable terminations are made on backboards and in cabinets and outlet boxes.

H. Wiring at Backboards and Cabinets: Install conductors parallel to and at right angles to walls. Bundle, lace, and train the conductors to terminal points with no excess. Use wire distribution spools at points where cables are fanned or conductors turned. Label each terminal.

I. Conductor Terminations: Terminate conductors of cables on terminal blocks using tools recommended by terminal block manufacturer.

3.5 GROUNDING

A. Provide equipment grounding connections for telephone systems as indicated. Tighten connections to comply with tightening torque specified in UL Standard 486A to ensure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL

A. Copper Cabling.
   1. Provide at least 10-days notice in writing when the cabling network is ready for final acceptance testing.
   2. All testing shall be in the presence of the Owner’s project representative.
   3. Test each UTP cable in accordance with EIA/TIA-568B guidelines to Category 6 performance testing parameters.
   4. Factory test results for patch cables will be acceptable where the factory testing parameters clearly meet or exceed the EIA/TIA-568B guidelines.
   5. Electronic test results shall be provided to the Owner’s project representative for review.

6. Any cable that fails to meet its specified performance characteristics shall be replaced with a new cable and retested.

B. Fiber-Optic Cabling.
1. Test each fiber strand in accordance with manufacturer's published test procedures.
2. Test each fiber strand at dual wavelengths.
   a. 850 nm and 1300 nm for multimode.
3. Cable performance shall meet or exceed the following performance criteria: multimode - 3.75 dB/km at 850 nm and 1.5 dB/km at 1310 nm.
4. Test each fiber strand with an optical time domain reflectometer (OTDR).
5. The OTDR anomaly resolution shall be within one foot in runs up to 1,000 feet in length.
6. Test all cable segments and patch cords for faulty connectors, splices, and terminations and for the integrity of the cable and its component parts at 850 and 1300 nm multimode.
7. Each connector shall test to a maximum of .1 dB loss.
8. Replace connectors on cables that exceed the .1dB limit and retest.
9. Replace connectors and retest new materials until satisfactory performance is achieved.
10. Use a time domain reflectometer to record transmission characteristics, waveform, and performance of all fiber strands.
11. Use an optical loss test set (OLTS) to measure the optical transmission loss (attenuation) on each optical fiber strand in the system.
12. Electronic test results shall be provided to the Owner’s project representative for review.

END OF SECTION 26 0523

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SECTION 26 0526

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install grounding materials in accordance with the plans and as specified herein.

B. Grounding: This section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this section may be supplemented in other sections of these Specifications.

C. Applications of electrical grounding and bonding work in this section include the following:
1. Underground metal piping.
2. Underground metal and steel reinforced concrete structures.
3. Electrical power systems.
4. Grounding electrodes.
5. Counterpoise loops.
6. Separately derived systems.
7. Raceways.
8. Service equipment.
9. Enclosures.
10. Equipment.
11. Lighting standards.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work to furnish and install grounding in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and National Electrical Code (NEC) as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment. Use of conduit system for ground conductor shall not be allowed.
2. Underwriters' Laboratories, Inc. (UL) Compliance: Comply with applicable requirements of UL Standards Nos. 467, "Grounding and Bonding Equipment", and 869 "Reference Standard for Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors". Provide grounding and bonding products which are UL listed and labeled for their intended usage.

3. Institute of Electrical and Electronic Engineers (IEEE) Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submittals: Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for ground rods, connectors and connection materials, and grounding fittings. Field testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
   2. Report of field tests and observations certified by the testing organization.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver ground wire properly packaged in factory fabricated type containers, or wound on NEMA specified type wire reels.

B. Handle grounding wire carefully to avoid abrading, puncturing and tearing wire insulation. Ensure that dielectric resistance of the cable is maintained

C. Store grounding materials and ground wire in clean dry space in original containers. Protect products from weather damaging fumes, construction debris, and traffic.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Grounding and Bonding Products
   1. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
   2. Conductor Materials: Copper

B. Wire and Cable Conductors
   1. General: Comply with Division 26 Section “Wires, Cables and Connectors”.
   2. Equipment Grounding Conductor
      a. Minimum ground wire size for power circuits shall be No. 12 AWG, except where otherwise noted. Wire size No. 8 AWG and larger shall be stranded, and all smaller wires shall be solid, except where otherwise noted.
      b. Minimum ground wire size for control circuits shall be No. 14 AWG, except where otherwise noted.
      c. All wire sizes shown on Plan Drawings, Details, and Sketches are based on insulated copper wire based on 60 deg C for circuits 125 amperes and less, and the use of 75 deg C for higher ampere rated circuits.
      d. Conductors for grounding system shall be soft or medium hard drawn, stranded, bare copper, except where otherwise noted.

3. All conductors buried in ground shall be bare.
4. Grounding Electrode Conductor: Stranded cable
5. Bare Copper Conductors: Conform to the following:
    a. Solid Conductors: ASTM B-3.
    b. Assembly of Stranded Conductors: ASTM B-8.
    c. Tinned Conductors: ASTM B-33.

C. Identification of Ground Conductors
1. Ground conductors shall have conductor identification.
2. Ground conductor identification shall be as called for in the National Electric Code, where covered.
3. Ground conductors larger than No. 6 AWG may be identified by taped color coding at all splices and terminations.
4. Ground conductors No. 6 AWG and smaller shall be color coded.
5. Ground conductor color coding shall be green throughout.
6. Wire markers made of paper tape shall not be used.

D. Miscellaneous Conductors
1. Ground Bus: Bare annealed copper bars of rectangular cross section with 98 percent conductivity, rigidly attach to structure.
2. Braided Bonding Jumpers: Copper tape, braided No. 30 gauge bare copper wire, terminated with copper ferrules.
3. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

E. Connector Products
1. General: Listed and labeled as grounding connectors for the materials used.
2. Pressure Connectors: High conductivity plated units.
3. Bolted Clamps: Heavy duty units listed for the application.
4. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

F. Grounding Electrodes
1. Ground Rods: Copper clad steel with high strength steel core and electrolytic grade copper outer sheath, molten welded to core.
    a. Size: 3/4 inch by 20 feet.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include the following:
1. Anixter Bros., Inc.
2. Bashlin Industries, Inc.
3. Buckingham Mfg. Co.
4. A.B. Chance Co.
5. Dossert Corp.
6. Engineered Products Co.
7. Erico Products, Inc.
8. Galvan Industries, Inc.
9. GB Electrical, Inc.
10. General Machine Products Co., Inc.

11. Hastings Fiber Glass Products, Inc.
12. Ideal Industries, Inc.
13. Kearney-National.
14. McGill Mfg.
15. O-Z/Gedney Co.
16. Raco, Inc.
17. Thomas & Betts Corp.
18. W.H. Salisbury & Co.
19. Utilco Co.

B. Exothermic Weld Connections
1. Cadweld.
2. Therm-O-Weld.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.
2. Ground Rods: Locate a minimum of one rod length from each other and at least the same distance from any other grounding electrode. Interconnect all ground rods with bare conductors buried at least 24 inches below grade. Connect bare cable ground conductors to ground rods by means of exothermic welds. Make these connections without damaging the copper coating or exposing the steel. Drive rods until tops are 2'-6" below finished floor or final grade except as otherwise indicated.
3. Metallic Water Service Pipe: Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground clamps. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings. Bond the ground conductor conduit to the conductor at each end.
4. Braided Type Bonding Jumpers: Install to connect ground clamps on meter piping to bypass meters electrically. Use elsewhere for flexible bonding and grounding connections.
5. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.
6. Provide ground rods and ground grid at service entrance equipment as required.
7. Bond the neutral of each transformer to building steel.
8. All underground grounding conductors shall be a minimum of 2'-6" below grade.
9. Provide a ground wire in all feeder circuits.
10. Provide a ground wire in all branch circuit conduits.
11. Where grounding conductors are subject to mechanical injury, they shall be protected by encasement in concrete or installed in a rigid schedule 80 PVC raceway.
12. All connection of ground conductors to ground rods, bus bars, structural members, pipes, or fences and splices of ground conductors shall be made by exothermic welds, except where otherwise noted.
    a. All connections to bar lugs shall be exothermic weld or compression type.

b. Bolted type connection of ground conductors may only be made where terminal lugs or blocks have been furnished and installed in equipment by the Manufacturer.
c. Prior to the installation of any exothermic weld on connector, all connecting surfaces shall be thoroughly cleaned in accordance with the Manufacturer's recommendations.
d. Failure to thoroughly clean connecting surfaces shall constitute justifiable ground to require the Contractor to remove and re-install all similar connections at no expense to the Owner or Engineer.

13. The Contractor shall not allow or cause any connection or splice for the grounding system to be covered up or enclosed until it has been inspected and approved by the Inspecting Authority.
    a. Any connection or splice that is covered up or enclosed before such inspection and approval shall be uncovered at the Contractor's expense.
    b. After it has been inspected and approved, the Contractor shall cover up or enclose the connection or splice it at his own expense.
14. The resistance to ground for the entire grounding system shall not exceed 25 ohms under normal dry conditions. Tests of grounding resistance shall not be made within 24 hr after a rainfall. If, after testing the system, it is found that the resistance exceeds the specified value, the Contractor shall install the necessary number of ground rods to reduce the resistance to less than the specified value.

B. Connections
1. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
    a. Use electroplated or hot tin coated materials to assure high conductivity and make contact points closer in order of galvanic series.
    b. Make connections with clean bare metal at points of contact.
    c. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
2. Exothermic Welded Connections: Use for connections to structural steel, connections to ground rods, and for all underground connections. Install at connections to ground rods. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
3. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
4. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
5. Compression Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

6. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

C. Underground Distribution System Grounding
   1. Manholes, Handholes, and Underground Pullboxes: Install a driven ground rod close to the wall and set the rod depth such that 4 inches will extend above the finished floor. Where necessary, install ground rod before the manhole is placed and provide a No. 1 AWG bare tinned copper conductor from the ground rod into the manhole through a waterproof sleeve in the manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure sensitive tape or heat shrunk insulating sleeve from 2 inches above to 6 inches below the concrete. Seal floor opening with waterproof nonshrink grout.
   2. Connections at Manholes, Handholes, and Underground Pullboxes: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole to the ground rod or ground conductor. Connect circuit ground wire to ground rod. Make connections with minimum No. 4 AWG stranded hard drawn copper wire. Train conductors plumb or level around corners and fasten to manhole or handhole walls. Connect to cable armor and cable shields by means of tinned terminals soldered to the armor or shield, or as recommended by manufacturer of splicing and termination kits.
   3. Grounding System: Ground noncurrent carrying metallic items associated with manholes, substations, and pad mounted equipment by connecting them to bare underground cable and grounding electrodes arranged as indicated.

3.2 APPLICATION

A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated. Use of conduit system for ground conductor shall not be allowed.
   1. Install separate insulated equipment grounding conductors with circuit conductors for the following in addition to those locations where required by code:
      a. Feeders and branch circuits.
   2. Nonmetallic Raceways: Install an insulated equipment ground conductor in nonmetallic raceways unless they are designated for telephone or data cables.

B. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.

C. Separately derived systems required by NEC to be grounded shall be grounded in accordance with NEC paragraph 250-30.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.

3.3 FIELD QUALITY CONTROL

A. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.

B. Test the complete station ground system for continuity and for resistance to ground using an electrical ground resistance tester.

C. Ground test shall be performed only after two days of dry weather. Dry weather is defined as 0.0-inch of precipitation in a 48 hour period.

D. Use a hand-cranked or motor-driven ground test set by Biddle, or approved equal.

E. Resistance to ground shall be 5 ohms or less. Drive additional ground rods as required to meet the 5 ohm maximum resistance.

F. All tests are to be witnessed by the Owner's Representative. Notify the Owner's Representative at least 24 hours in advance of testing.

END OF SECTION 26 0526

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SECTION 26 0529

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to work of this Section.

B. This section is a Division 26 section and is a part of each Division 26 section making reference to electrical supporting devices specified herein.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install supporting devices in accordance with the plans and as specified herein.

B. Supports: Types of supports, anchors, sleeves and seals specified in this section include the following:
1. Clevis hangers.
2. Riser clamps.
3. C-clamps.
4. I-beam clamps.
5. One hole conduit straps.
6. Two hole conduit straps.
7. Round steel rods.
8. Lead expansion anchors.
9. Toggle bolts.
10. Wall and floor seals.
11. U-channel strut system.

C. Supports, anchors, sleeves and seals furnished as part of factory fabricated equipment, are specified as part of that equipment assembly in other divisions and Division 26 sections.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. National Electrical Code (NEC) Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.
2. Manufacturer's Standardization Society (MSS) Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.
3. National Electrical Contractors Association (NECA) Compliance: Comply with NECA's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

4. Underwriters' Laboratories, Inc. (UL) Compliance: Provide electrical components which are UL listed and labeled.
5. Federal Specification (FS) Compliance: Comply with FS FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

1.4 DEFINITIONS

A. Abbreviations
1. PVC: Polyvinyl chloride.

B. Finished Locations: The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

F. Hazardous (classified) Locations: The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
1. Product data for the U-channel strut system.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Deliver supporting devices properly packaged in factory fabricated type container.

B. Store supporting devices in clean dry space in original containers. Protect products from weather damaging fumes, construction debris and traffic.

C. Handle supporting devices carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Products shall include but are not limited to the following:
   1. Materials
      a. Corrosive locations. Type 316 stainless steel or PVC coated galvanized steel.
      b. Exterior locations. Type 316 stainless steel.
      c. All other locations. Steel or malleable iron, electro-galvanized.
   2. Clevis Hangers: For supporting rigid metal conduit.
      a. 3/8-inch rod for 2 inch and smaller conduit.
      b. 1/2-inch rod for 2 1/2 inch and larger conduit.
   3. Threaded Rod: 1/2-inch minimum size except as stated in 1 above with hexagon nuts.
   4. Beam Clamp: With 1/4-inch tapped side and back holes for attachment of conduit clamps.
   5. Swivel Beam Clamp: Swivel eye hook, closed in the installed position, swivel eye tapped for the threaded rod, and jamb nut.
   6. One-Hole Conduit Straps: One hole.
   7. Clamp Backs: For use with one hole conduit strap to support conduit away from wall or ceiling surface.
   8. Conduit Hangers: For hanging conduit from beam clamps, 1/4-20 closure bolt and square nut, hole for 1/2-13 threaded rod.
   9. Conduit Spacers: Nonmetallic spacers to support conduit and maintain spacing during concrete pours.
   10. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
      a. Appleton.
      b. Cal Conduit Products.
      c. Cantex, Inc.
      d. Carlon.
      e. Cooper B-line
      f. Crouse-Hinds.
      g. Gibson Stainless and Specialty, Inc.
      h. Killark.
      i. Occidental Coating Co.
      j. Raco, Inc.
      k. Robroy.
      l. Thomas & Betts Corp.

B. Cable and Cord Supports
   1. External Cable Grips
      a. For flexible cords and cables longer than 6 feet and steel support wire.
      b. Lace type split wire mesh.
      c. Single or double weave as required to support the load with a safety factor of 10 times the supported load.
      d. Type 302/304 stainless steel
   2. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
      a. B-Line Systems.
      b. Condux International, Inc.
      c. Kellems, Division of Hubbell, Inc.

d. O-Z/Gedney.
e. Pass & Seymour/Legrand.
f. Red Seal Electric Co.

2.2 U-CHANNEL STRUT SYSTEMS

A. General
1. Provide equipment that is listed and labeled.
2. U-channel
3. Materials
a. Corrosive locations: Type 316 stainless steel.
b. Exterior locations: Type 316 stainless steel.
c. All other locations: Cold rolled steel, ASTM A570, grade 33, 12 gauge, hot dip galvanized after fabrication.
4. Outside dimensions of 1-5/8 inch x 1-5/8 inch, unless otherwise noted.
5. Holes, 9/16 inch diameter at 1-7/8 inch on center, unless otherwise noted.
6. Provide spring nuts, clamps, hangers, and hardware made of the same materials at the U-channel.

B. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
1. Cooper/B-Line.
2. Gibson Stainless and Speciality, Inc.
3. Kindorf/Thomas & Betts.
4. Seasafe, Inc.
5. Unistrut Corporation.

2.3 FABRICATED SUPPORTS

A. General.
1. Constructed of individual structural shapes or assemblies of structural shapes welded together to form a complete, secure, and durable assembly.
2. Structural tubing, angles, channels, or W-shapes as shown on the drawings or required to support equipment or systems.
3. Size support members to perform their support functions without deflection of more than one half percent of total height for vertical members and 1 percent of total span for other than vertical members.
4. Materials
a. Corrosive locations: Type 316 stainless steel.
b. Exterior locations: Type 316 stainless steel.
c. All other locations: Cold rolled steel, ASTM A 36 hot dip galvanized after fabrication.

B. Fabrication
1. Steel: Assemble fabricated supports by full penetration welded connections.
2. Ground welds smooth and flush.
3. Wire brush areas around welds to remove slag and spall.

2.4 WALL AND FLOOR SEALS

A. General: Provide seals around conduits that penetrate below grade or water-bearing concrete walls and floors.

B. Wall Opening
   1. New Walls: Molded non-metallic high density polyethylene sleeves with integral water stop and end caps to prevent deformation during concrete pour.
   2. Existing Walls: Core drilled hole, size as recommended by seal manufacturer.

C. Modular seal.
   1. Inter-locking synthetic rubber links shaped to fill the annular space between the conduit and the wall opening.
   2. Glass reinforced nylon polymer pressure plates.
   3. Type 316 stainless steel bolts and flange hex nuts.

D. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
   1. PSI-Thunderline/Link-Seal.
   2. Or approved equal.

2.5 FIRE-STOPS

A. General
   1. Provide fire-stops around any electrical work penetrating fire rated walls, floors, or ceilings.
   2. Provide fire-stops that conform to the following:
      a. UL Standard 1479, "Penetration Fire-stop Systems."
      b. UL Standard 263, "Fire Tests of Building Construction and Materials."

B. Busway, Cable Tray, Armored Cable, and Conduit Penetration Fire-Stopping
   1. Provide expanding foam or elastomeric putty or pillows to fire-stop penetrations in fire rated assemblies.
      a. RTV Foam
         1) Dow Corning 3-6548 Silicone RTV Foam.
         2) 3M Fire Barrier 2001 Silicone RTV Foam.
      b. Elastomeric Putty
         1) 3M Fire Barrier 2000 (nonslump).
         2) 3M Fire Barrier 2003 (self-leveling).
         3) Nelson CLK N/S (nonsag).
         4) Nelson CLK S/L (self-leveling).
   2. Provide fire resistive panels on both sides of the fire barrier penetration if required to obtain the necessary fire resistance rating or to provide a cofferdam to restrain the sealant material during the installation and curing process.
      a. 3M Fire Barrier CS-195+.
      b. Nelson CPS.
      c. Or approved equal.

2.6 ANCHORS AND FASTENERS

A. General
   1. Provide anchors and fasteners, including bolts, nuts, washers of types, sizes and materials indicated.
   2. Materials
      a. Corrosive locations: Stainless steel.
      b. Exterior locations: Stainless steel.
      c. All other locations: Galvanized steel.
   3. Anchors for securing 3/4 or 1 inch conduit straps and device boxes to sound concrete walls and ceilings shall be self-tapping anchors, similar and equal to Hilti Kwik-Con II or ITW Buildex Blue Max, 3/16 inch by minimum 1 1/4 inches long, in areas not requiring stainless steel.
   4. For anchors for use in securing conduit larger than 1 inch, heavier equipment than device boxes, and all fasteners to be used in areas enumerated above as requiring stainless steel fasteners, provide stud type expansion anchors, drop-in two-piece expansion anchors, or adhesive stud anchors, similar and equal to Hilti Kwik-Bolt II, Hilti HDI Drop-in, or Hilti HVA Adhesive Anchor System.
   5. Lead Expansion Anchors: 1/2 inch.
   6. Toggle Bolts: Springhead, 3/16 inch x 4 inch.

B. Manufacturers: Subject to compliance with requirements, available manufacturers include, but are not limited to, the following:
   1. Ackerman Johnson Fastening Systems Inc.
   2. Ideal Industries, Inc.
   3. Hilti.
   4. Joslyn Manufacturing and Supply Co.
   5. ITW Buildex.
   6. Ideal Industries, Inc.
   7. Rawlplug Co.
   8. Star Expansion Co.
   9. U.S. Expansion Bolt Co.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

D. Install conduit seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal. Provide seals for the interior of conduits which penetrate exterior or water bearing walls, consisting of gland type sealing bushings or RTV closed cell silicone foam.

END OF SECTION 26 0529

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SECTION 26 0533

RACEWAY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
1. Flexible metal conduit (FMC).
2. Intermediate metal conduit (IMC).
3. Liquid-tight flexible metal conduit (LFMC).
4. Liquid-tight flexible non-metallic conduit (LFNC).
5. PVC coated rigid metal conduit.
6. Rigid aluminum conduit (RAC).
7. Rigid non-metallic conduit (RNC).
8. Surface raceway.
9. Wireway.

B. Related Sections
1. Division 01 section "Submittal Procedures."
2. Division 26 section "Basic Electrical Requirements."
3. Division 26 section "Basic Electrical Materials and Methods."
4. Division 26 section "Grounding."
5. Division 26 section "Supporting Devices."
6. Division 26 section "Electrical Identification."
7. Division 31 section "Excavation and Fill."

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. American National Standards Institute (ANSI)
1. C80.1 Standard for Electrical Rigid Steel Conduit (ERSC).
2. C80.3 Standard for Steel Electrical Metallic Tubing (EMT).
3. C80.5 Standard for Electrical Rigid Aluminum Conduit (ERAC).

C. National Electrical Contractors Association (NECA) Electrical Installation Standards
1. 101-2006 Standard for Installing Steel Conduit (Rigid, IMC, EMT)
2. 102-2004, Standard for Installing Aluminum Rigid Metal Conduit
3. 111-2003, Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)

D. National Electrical Manufacturers Association (NEMA)
1. RN 1 Polyvinyl-chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

2. TC-2 Electrical Polyvinyl Chloride (PVC) Conduit.

E. National Fire Protection Association (NFPA)
1. NFPA70 – The National Electrical Code (NEC).

F. Underwriter's Laboratory (UL)
1. Standard 1 Flexible Metal Conduit
2. Standard 5 Surface Metal Raceway and Fittings
3. Standard 6 Rigid Metal Conduit
4. Standard 50 Enclosures for Electrical Equipment
5. Standard 360 Liquid-Tight Flexible Steel Conduit
6. Standard 467 Grounding and Bonding Equipment
7. Standard 514A Metallic Outlet Boxes
8. Standard 514B Fittings for Cable and Conduit
9. Standard 651 Schedule 40 and 80 Rigid PVC Conduit
10. Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit
11. Standard 797 Electrical Metallic Tubing
12. Standard 1242 Intermediate Metal Conduit
13. Standard 1660 Liquid-Tight Flexible Nonmetallic Conduit

1.4 DEFINITIONS

A. Abbreviations
1. AHJ: Authority having jurisdiction.
2. NRTL: Nationally recognized testing laboratory.
3. PVC: Polyvinyl chloride.

B. Finished Locations: The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

F. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information necessary to determine compliance with the plans and specifications.
   4. Identify all products submitted as substitutions.

B. Product Data
   1. Manufacturer’s technical product data sheets for all products specified in this section.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
   1. Materials list. Submit a list with quantities, manufacturer’s name, and catalog numbers.
   2. Dimensional drawings. Submit dimensional drawings for all products.
   3. Mounting details.
   4. Wiring diagrams: Submit wiring diagrams for all products.
      a. Show all components and features specified.
      b. Differentiate between factory and field installed wiring and components.

D. Samples

E. Quality Control Submittals
   1. Test Reports
      a. Field test report. Submit certified copies of the field test reports.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. All applicable federal, state, and local codes and regulatory requirements.
   2. National Electrical Code (NEC).

1.7 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirements Sections.

B. Packing and shipping
   1. Package equipment as required to prevent damage during shipment.
   2. Mount heavy items on pallets or skids to facilitate handling.

C. Storage and protection
   1. Store the products until they can be installed.
   2. Meet the storage requirements of the manufacturer.

1.8 PROJECT/SITE CONDITIONS

A. Field Measurements: Field verify all locations and dimensions.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Provide products listed and labeled by an approved independent NRTL.
   3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 CONDUITS

A. Minimum Conduit Size
   1. For Connection to Recessed Lighting Fixtures: 1/2 inch.
   2. For Connection to Field Instruments with Only 1/2 Inch Openings or Hubs: 1/2 inch.
   3. Duct Banks: 1 inch.
   4. All Other Uses: 3/4 inch.

B. Metal Conduit and Tubing
   1. Rigid Aluminum Conduit: Rigid aluminum conduit, threaded type, ANSI C80.5, UL6A.
   2. Intermediate Steel Conduit. Intermediate grade, hot dip galvanized, ANSI C80.1, UL 1242.
   3. Flexible Metal Conduit. Continuous, spirally wound, interlocked aluminum, UL 1
   4. Liquid-tight Flexible Metal Conduit: Continuous, spirally wound, interlocked aluminum, flexible liquid-tight PVC jacket, UL 360.
   5. Available Manufacturers: Subject to compliance, metal conduit manufacturers include, but are not limited to:
      a. AFC.
      b. Alflex Corp.
      c. Allied Tube and Conduit.
      d. Alumax.
      e. Electri-Flex Company.
      f. LTV Steel Tubular Products Co.
      g. Occidental Coating Co.
      h. Perma-Cote Industries.
      i. Robroy Industries, Inc.
      j. Shamrock Conduit Products.
      k. Tiften Aluminum Co.
      l. Triangle PWC, Inc.
      m. VAW of America Inc.
      n. Wheatland Tube Co.

C. Nonmetallic Conduit
   1. Rigid Nonmetallic Conduit: PVC, Schedule 40, NEMA TC-2, UL 651.
   2. Rigid Nonmetallic Conduit (Heavy Wall): PVC, Schedule 80, NEMA TC-2, UL 651.
   3. Liquid-tight Flexible Nonmetallic Conduit: Continuous hard PVC spiral encapsulated with flexible PVC, UL 1660.
   4. Available Manufacturers: Subject to compliance, non-metallic conduit manufacturers include, but are not limited to:
      a. Alflex.
      b. Cantex Industries.
      c. Carlon.

d. Certainteed.
e. Cole Flex-Corp.
f. Electric-Flex.

2.3 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Bodies
1. Provide covers and gaskets secured with corrosion resistant screws.
2. Rigid Metal: Threaded aluminum, UL 514B.
3. Hazardous locations. Threaded aluminum approved for hazardous locations as identified on plans.
4. Nonmetallic: PVC, molded solvent weld connector, UL 514B.

B. Locknuts: Galvanized steel, bonding type with sharp edge for digging into metal, UL 514B, NEMA FB-1. Set screw type grounding terminal where required.

C. Bushings: Malleable iron, galvanized, integrally molded insulation, UL 514B, NEMA FB-1. Set screw type grounding terminal where required.

D. Conduit Hub Assemblies: Cast metal, ribbed body with female threads, o-ring gasket, integral conduit nipple with insulated throat, grounding type locknut, UL 514B.

E. Expansion Fittings
1. Rigid Aluminum Conduit: Aluminum body and sleeve, threaded ends, grounding type, rated for location where required.
2. Rigid Non-Metallic Conduit: PVC body and sleeve, two o-rings, socket connector each end.

F. Other Fittings
1. Rigid Metal: Threaded aluminum.
2. Liquid-Tight Flexible Metal: Compression type, galvanized steel or malleable iron body, steel ferrule, sealing gland and gasket, insulated throat.
3. Rigid Nonmetallic: PVC, molded solvent weld connector, NEMA TC 3.
4. Liquid-Tight Flexible Nonmetallic: PVC, one piece body, compression ferrule, sealing gland and gasket.

G. Explosion-Proof Seals: Rated use in Class I, Division 1, Group D atmosphere.

H. Explosion-proof couplings. Braided wire outer jacket, insulating inner liner, threaded ends, liquid-tight, length as required. Rated for use in Class I, Division 1, Group D hazardous locations.

I. Conduit Seals
1. Duct Sealing Putty
a. Gray pliable mastic.
b. Non-shrink, non-hardening and UV resistant.
c. Compatible with wire insulation.
d. Listed for use with conduit sealing fitting.
2. Mechanical Seals
a. Internal sealing bushing.
b. Two stainless steel pressure discs

c. Three stainless steel socket head cap screws
d. Neoprene gasket.
e. Pressure discs and gasket factory predrilled to match size/quantity of cables.
f. Rated to withstand 50 pounds per square inch gauge (psig) water or gas pressure.

3. Expanding foam sealant
   a. Two part foam that expands in place to fill voids between cables and conduits.
   b. Compatible with wire/cable insulation.
   c. Withstands 15 feet of water head.
4. Expanding Foam Fire Stop Sealant
   a. Two part silicone foam that expands to fill voids between cables and conduits.
   b. Compatible with wire/cable insulation.
   c. Intumescent, listed as a fire barrier.

J. Available Manufacturers: Subject to compliance, conduit fitting manufacturers include, but are not limited to:

1. Fittings
   a. Adalet/PLM.
   b. Appleton Electric.
   c. Carlon.
   d. Condux International, Inc.
   e. Crouse-Hinds.
   f. Delta Industrial Products.
   g. Electri-Flex Company.
   h. Killark Electric Mfg. Co.
   i. Kraloy Products Co.
   j. O.Z. Gedney.
   k. Perma-Cote Industries.
   l. Raco.
   m. Robroy Industries.
   n. Spring City Electrical Mfg. Co.
   o. Steel City.
2. Sealants
   a. 3M.
   b. Dow.
   c. Gardner Bender Electrical.
   d. Panduit.

2.4 WIREWAYS

A. General Purpose Wireways. NEMA 1 steel, front accessible, totally enclosed with bolted covers. Finished with rust-inhibiting primer and gray baked enamel finish.

B. Oil-tight Wireways. NEMA 12, oil-tight and dust-tight steel with hinged cover and gasket, external latches, and flanged joints with gaskets. Finished with gray baked enamel inside and outside.

C. Watertight Wireways. NEMA 4X, watertight, corrosion resistant stainless steel with hinged cover and gasket, screw clamps, and flanged joints with gaskets.

D. Available Manufacturers. Subject to compliance, wireway manufacturers include, but are not limited to:

1. American Electric.
2. Anchor Electric Co.
3. B-Line Systems, Inc.
4. Circle AW Products.
5. Cross Brothers, Inc.
6. Erickson Electric Equipment Co.
7. GS Metals Corp.
8. Hoffman Engineering Co.
9. Square D Company.
10. Wadsworth Electric Manufacturing Co., Inc.

2.5 SURFACE RACEWAYS

A. Metal Raceways. [Aluminum] [Galvanized steel] with snap-on covers. 1/8-inch mounting screw, knockouts in base approximately 8 inches on center. Finished with rust-inhibiting primer suitable for painting.

B. Nonmetallic Raceways. Two piece construction, rigid PVC with matte texture conforming to UL 94.

C. Available Manufacturers. Subject to compliance, surface raceway manufacturers include, but are not limited to:
1. Surface Metal Raceway.
    a. Alrey-Thompson Co., Inc.
    b. Allied Tube & Conduit.
    c. American Electric.
    d. B-Line Systems, Inc.
    e. Butler Mfg. Co.
    f. Erickson Electrical Equipment Co.
    g. GS Metals Corp.
    h. Haydon Corp.
    i. Hoffman Engineering Co.
    j. Isoduct Energy Systems.
    k. Isotrol Systems.
    l. Keystone/Rees, Inc.
    m. SL Industries, Inc.
    n. Square D Co.
    o. The Wiremold Co.
2. Surface Nonmetallic Raceway.
    a. Anixter Brothers, Inc.
    b. Hoffman Engineering Co.
    c. Hubbell, Inc.
    d. JBC Enterprises, Inc.
    e. Panduit Corp.
    f. Premier Telecom Products, Inc.
    g. Thermotools Co.
    h. The Wiremold Co.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Inspect installed work prior to performing the work of this section.
   2. Verify that the project has progressed to a point where this installation may begin.

B. Material Inspection.

C. Discrepancies:
   1. Immediately notify the Engineer in writing of conditions detrimental to proper completion of the work.
   2. Correct all unsatisfactory conditions before proceeding with installation.
   3. Resolution must be acceptable to the Engineer.

3.2 RACEWAY APPLICATIONS

A. Conduit
   1. Connections to Motors or Vibrating Equipment
      a. Hazardous locations: Flexible coupling rated for the area.
      b. Corrosive locations: Liquid-tight flexible non-metallic conduit, 18 inch maximum length.
      c. Wet locations: Liquid-tight flexible metal conduit, 18 inch maximum length.
      d. All other locations: Liquid-tight flexible metal conduit, 18 inch maximum length.
   2. Concealed in Walls and Fixed Ceilings
      a. Hazardous locations: Do not conceal conduits.
      b. Corrosive locations: Do not conceal conduits.
      c. Wet locations: Do not conceal conduits.
      d. Finished locations: Rigid aluminum conduit.
      e. All other locations: Do not conceal conduits.
   3. Concealed in Accessible Floors and Ceilings
      a. Finished locations: Rigid aluminum conduit.
      b. Connections to lighting fixtures: Flexible metal conduit, 6 feet maximum length.
      c. All other locations: Rigid aluminum conduit.
   4. Concealed in Concrete
      a. Hazardous locations: Schedule 40 PVC conduit.
      b. Corrosive locations: Schedule 40 PVC conduit.
      c. Wet locations: Schedule 40 PVC conduit.
      d. Transitions from concealed in concrete to exposed: Schedule 80 PVC conduit.
      e. All other locations: Schedule 40 PVC conduit.
   5. Exposed
      a. Hazardous locations: Rigid aluminum conduit.
      b. Corrosive locations: Schedule 80 PVC conduit.
      c. Wet locations: Rigid aluminum conduit.
      d. Finished locations: Do not expose conduits in finished areas.
      e. All other locations: Rigid aluminum conduit.
   6. Underground
      a. Direct buried: Schedule 80 PVC conduit
      b. Concrete encased: Schedule 40 PVC conduit.
      c. Transitions from underground to exposed: PVC coated RMC.

B. Fittings
   1. Use threaded fittings and conduit bodies for rigid aluminum conduit.
   2. Use reducing couplings or bushings for transitions between conduit sizes.

C. Conduit Seals
1. Use hazardous location sealing fitting where required by the NEC.
2. Use expanding foam fire stop sealant in fire rated wall, floor, and ceilings.
3. Use mechanical seals in exterior below grade walls, floors, and ceilings.
4. Use expanding foam sealant for all other conduit seals.

D. Wireways
1. Finished locations: Do not use wireways in finished locations.
2. All other locations: Use NEMA 4X wireways.

E. Surface raceway:
1. Use only where shown.

3.3 PREPARATION

A. Surface Preparation
1. Carefully lay out the work in advance.
2. Perform all cutting, drilling, etc. without damaging the building surfaces or equipment.

B. Rough-in
1. Refer to equipment submittals for rough-in requirements.
2. Verify rough-in locations by field measurements.
3. Maintain all manufacturer recommended clearances.

3.4 CONDUIT INSTALLATION

A. General
1. Install raceways in accordance with the following:
a. Manufacturer's written installation instructions
b. NECA 1, NEC, and UL
2. Remove and replace the damaged raceways with new undamaged material.
3. Install plumb and level.
4. Install complete runs before pulling in cables or wires.
5. Cap all conduits after installation with factory made closures.
6. Install pull rope in all spare or empty conduits.
7. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength.
8. Make pull-line continuous from outlet to outlet, with two feet of slack at each outlet.
9. Embed the ends in duct sealing compound.
10. Provide enough slack in flexible conduits to facilitate maintenance of equipment.
11. Limits bends between pull points to no more than 4 bends totaling 360 degrees.

B. Field fabrication and assembly
1. General
a. Make all bends with standard conduit bending tools and machines.
b. Do not to distort or vary the internal diameter when field bending.
c. Keep legs of bends in the same plane.
d. Keep straight legs of offsets parallel, unless otherwise indicated.
e. Make couplings and connections watertight.
f. Remove and replace dented or deformed conduit with new undamaged material.
g. Cut conduits straight
h. Ream cut ends to remove burrs.

2. Rigid Aluminum Conduit
    a. Ream cut ends before threading.
    b. Do not use running threads at conduit joints and terminations.
    c. Clean the threads and conduit interior with a degreasing spray.
3. PVC Coated RMC
    a. General
        1) Follow general conduit installation requirements except as modified below.
        2) Follow the manufacturer's recommended installation procedures.
        3) Protect PVC coating on conduit and fittings from damage prior to and during the Work.
    b. Cutting and threading.
        1) Cut conduit using only roller cutters.
        2) Replace pipe vise jaws with jaws designed for use with PVC coated conduit.
        3) Use power drive unit inserts designed for use with PVC coated conduit.
        4) Use half shell conduit clamps in chain vises.
        5) Machine threading tool stationary guide to accommodate the PVC coating.
        6) Make longitudinal release cuts in the PVC coating before threading.
        7) Clean the threads and conduit interior with a degreasing spray.
        8) Apply touchup compound to any unprotected metal.
    c. Bending
        1) Use bending shoes specifically designed for PVC coated conduit in mechanical bending equipment.
        2) Use shoes one size larger than the size of the conduit when hand bending.
        3) Use bending hickeys that have a PVC coating.
    d. Assembly
        1) Use strap wrenches or wide jaw pliers designed for PVC coated conduit.
        2) Use nut drivers for encapsulated fasteners on conduit body and enclosure covers.
    e. Repair and replacement
        1) If PVC coating of conduit or fittings is damage during installation, remove and replace with new undamaged materials.
        2) Repair minor scratches or damage in PVC coating with touchup compound where allowed by the Owner's representative.
4. Rigid Nonmetallic Conduit
    a. Solvent weld all joints in PVC conduit to provide a watertight seal.
    b. Provide a seal that maintains pressure of 25 pounds per square inch for 1 hour.

C. Routing
1. General.
    a. Locations are approximate unless dimensioned.
    b. Install exposed conduits parallel or perpendicular to walls, ceilings, or structural members.
    c. Run parallel or banked raceways together on common supports where practical.
    d. Make bends in parallel or banked runs from same center line.
    e. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
    f. Avoid conflicts with equipment and building components.
    g. Do not run through structural members.
    h. Avoid horizontal runs within partitions or walls.
    i. Align raceways to enter boxes and cabinets squarely.
    j. Avoid ceiling inserts, lights, or ventilation ducts or outlets.

k. Do not run across pipe shafts or ventilation duct openings
l. Maintain 6 inches of separation to parallel runs of flues and other heat sources.
m. Install horizontal runs above water and steam piping wherever possible.
n. Install horizontal runs close to ceilings or beams.
o. Do not encroach into the head room of walkways and doors.
p. Do not install within fume/vent hoods except where serving the fume/vent hood.
q. Provide a low point in conduit runs before entering boxes/enclosures.
r. Install a tee conduit fitting and drain/breather at the low point.
s. Enter the bottom of boxes/enclosures located in wet, hazardous, or corrosive areas.

2. Finished Areas
   a. Conceal in walls, slabs, or ceilings.
   b. In existing areas, conceal in walls of stud construction and above suspended ceilings.
3. Installed in Concrete
   a. Install in concrete only where specifically shown or specified.
   b. Do not install in waterproofed or water-bearing walls.
   c. Do not install through concrete beams.
   d. Do not install in concrete that is less than 3 inches thick.
   e. Do not install in concrete with a thickness less than 3 times the conduit diameter.
   f. Do not install between the reinforcing steel and the surface of the concrete.
   g. Space parallel runs at twice the diameter of the largest conduit, center to center.
   h. Do not cross conduits in slabs unless reviewed by the Engineer/Architect for proper cover.
   i. Make transitions from embedded to exposed with a metal conduit extending 1 inch into concrete.
4. Other Interior Areas
   a. Where equipment is more than 3 feet from walls, run in or under the floor and stub up.
   b. Run all other interior conduits exposed.
5. Exposed Exterior
   a. Do not run exposed on the exterior surface of buildings.
   b. Do not run across access openings in handrail.
   c. Do not run on the inside walls of tanks.
6. Underground Conduits
   a. Encase all underground conduits in concrete unless otherwise noted.
   b. Where noted as direct buried, provide 6 inches of sand above and below conduits.
   c. Depth below finished grade to top of underground conduits.
      1) Circuits less than or equal to 600 Volts. 24 inches.
      2) Circuits greater than 600 Volts. 36 inches.
   d. Provide excavation and backfill as specified in Division 31 Section, “Excavation and Fill”.
   e. Make all changes of direction with bends of 30 inch radius minimum.
   f. Space conduits 7.5 inches center to center both horizontally and vertically.
   g. Slope away from buildings with a minimum pitch of 3 inches per 100 feet.
   h. Mark underground conduit runs as specified in Section 260553, Electrical Identification.
   i. Provide reinforcing steel for 5 feet beyond excavation where conduits cross back-filled areas.
   j. Run parallel to plant coordinate axes when outside of structures and underground, unless otherwise shown.

D. Supports
   1. Support all conduits as specified in Section 260529, Supporting Devices.
   2. Support all conduits entering structures as shown on the Drawings.
   3. Use only products listed as conduit supports.
   4. Do not attach any parts of the conduit system to ventilation ducts.
   5. Attached conduit supports to the building.
   6. Support conduits on each side of bends.
   7. Support conduits at a spacing not to exceed the following:
      a. Six feet for conduits smaller than 1-1/4 inches
      b. Eight feet for conduits 1-1/4 inches and larger.
   8. Use waterproof cement to set conduit anchors in water bearing or waterproofed walls.
   9. Securely anchor underground conduits to prevent movement during placement of concrete or backfill.
   10. Secure embedded raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   11. Use precast separators and heavy gauge wire ties or other approved fasteners.
   12. Support conduits independently of suspended ceilings, lighting fixtures.
   13. Unless otherwise shown or specified, support conduit independently of process piping, mechanical piping, or mechanical ducts.
   14. Support within 1 foot of changes of direction, and entries to boxes or enclosures.

E. Sealing and Penetrations
   1. Seal the interior of the following conduits to prevent migration of moisture and gases:
      a. Conduits passing from warm to cold locations.
      b. Conduits passing between areas where air pressure differential must be maintained.
      c. Conduits subject to condensation.
      d. Conduits passing from the interior to the exterior of a building.
      e. Conduits penetrating exterior below grade walls, floors, and ceilings.
      f. Conduits entering any panelboard, switchboard, switchgear, or motor control center.
      g. Conduits entering any control panel.
      h. Conduits entering all exterior manholes, handholes, and boxes.
      i. Empty or spare conduits.
   2. Seal the interior of all conduits penetrating fire rated walls, floors, and ceilings.
      a. Seal penetrations with a fire rated sealant.
      b. Install fire rated sealants in accordance with manufacturer's instructions.
      c. Provide a foam depth of at least one conduit trade size.
   3. Conduit Stub-Ups
      a. Protect stub-ups from damage where conduits rise through floor slabs.
      b. Arrange stub-ups so curved portion of bends are not visible above the finished slab.
      c. Terminate stub-ups that are more that 6 inches from a wall with a threaded metal coupling and plug installed flush with the floor.
      d. Terminate all other stub-ups with a threaded cap or a bushing and penny.
   4. Provide wall and floor seals at conduit penetrations as specified in Section 260529, Supporting Devices.
   5. Roofs:
      a. Penetrate roofs only where specifically shown in the Contract Documents.
      b. Provide penetrations that meet the requirements of Division 07, Thermal and Moisture Protection.

F. Grounding
1. Mechanically assemble metal raceways to form a continuous effective grounding path.
2. Ensure that terminations at boxes and enclosures provide an effective ground connection.
3. Provide grounding bushings for the following metallic conduit connections:
   a. Circuits of more than 100 amperes.
   b. Connections through concentric, eccentric or oversize knockouts.
   c. Flexible conduit connections
   d. Any enclosure entry without an effective electrical connection.
4. Locknut and Bushing Grounding Lugs
   a. Bond together all lugs within the same box or enclosure with bonding jumpers.
   b. Bond lugs to the enclosure ground bus where provided.
   c. If a ground bus is not provided, bond lugs to an enclosure grounding stud or screw.
   d. For conduit transitions to cable tray, bond bushing ground lug to tray ground clamp.
5. Size bonding jumpers in accordance with NEC table 250.102.
6. Apply approved conductive joint compound to mating surfaces of all grounding connections.

G. Painting and Coating
1. Coat all field cuts and threads with brush applied cold process galvanizing, ASTM A 780.
2. Coat aluminum conduits with a dielectric isolating compound where installed in contact with reinforced concrete.

H. Identification: Identify conduits as required in Division 26 Section “Electrical Identification”.

3.5 CONDUIT FITTING INSTALLATION

A. General
1. Join with fittings designed and approved for that purpose.
2. Make-up couplings, fittings, and locknuts wrench-tight.
3. Install locknuts with dished side against box.
4. Use approved conductive thread compounds on all threaded connections.
5. Install a bushing on all conduit ends.
6. Provide a tee fitting with drain/breather at all low points.
7. Terminate Rigid Aluminum Conduit at NEMA 1 and NEMA 12 boxes and enclosures with two locknuts, one inside and one outside, and a bushing.
8. Terminate Rigid Aluminum Conduit at NEMA 3R, NEMA 4, NEMA 4X boxes and enclosures with conduit hub assemblies or in integral hubs where available.

B. Hazardous Locations
1. Provide sealing fittings where required by the NEC.
2. Follow the installation instructions of the manufacturer.

C. Expansion Fittings
1. Provide expansion fittings wherever structural expansion joints are crossed.
2. Provide expansion fittings for every 200 feet of linear run.
3. Provide expansion and deflection couplings wherever shown.
4. Install expansion fittings within one foot to five feet of structural expansion joint.
5. Do not use expansion fittings to compensate for misalignment of conduits.
6. Seismic Areas:
   a. Provide a rigidly attached junction box on each side of structural expansion joints.

b. Connect junction boxes with flexible conduit and provide 15 inches of slack.

3.6 WIREWAY AND SURFACE RACEWAY INSTALLATION

A. General:
1. Install in accordance with the following:
   a. Manufacturer's written installation instructions
   b. NECA 1, NEC, and UL.
2. Install only where shown.
3. Install plumb and level.
4. Install parallel or perpendicular to wall, floors, ceilings, or structural members.
5. Mechanically assemble to form continuous electrical conductor.
6. Support as specified in Division 26 section "Supporting Devices."

B. Rough-in dimensions:
1. Use dimensions for utilization equipment that are provided in the submittals.
2. Maintain all manufacturer recommended clearances.
3. Install only after the locations clear with other trades.

C. Supporting: Support as specified in Division 26 section "Supporting Devices.".

3.7 FIELD QUALITY CONTROL

A. Check alignment and condition of conduits:
1. Pull a mandrel and swab through every completed conduit run.
2. Use an iron shot mandrel:
   a. Mandrel diameter: 1/4 inch less than nominal conduit size
   b. Mandrel length: Equal to the conduit diameter.
   c. Gasket diameter: Slightly larger than the conduit opening.
3. Draw mandrel through without mechanical assistance.
4. If obstructions are encountered that cannot be removed, correct or replace conduit.

B. Test Nonmetallic Conduits for Leaks
1. Test conduits after conduit run is complete and cemented joints are set.
2. Conduct test as recommended by manufacturer.
3. Exercise caution, low-pressure air can cause high thrust loads.

C. Notify the Engineer for inspection and sign-off of the following installations:
1. Conduits to be direct buried: Notify the Engineer prior to covering.
2. Conduits to be embedded in concrete: Notify the Engineer prior to pouring concrete.
3. Document when each conduit is tested and cleaned and submit test report.

3.8 CLEANING

A. Conduits
1. Pull a stiff brush through each conduit until it is clear of foreign materials.
2. Clean existing ducts used for new cable in the same manner as noted above.

B. Wireways: Remove any dirt or debris from wireways before installing wiring.

END OF SECTION 26 0533

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SECTION 26 0543

MANHOLES, HANDHOLES, AND UNDERGROUND PULL BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install manholes and handholes in accordance with the plans and as specified herein.

B. Underground Work: This section includes underground electrical work including the following:
   1. Manholes.
   2. Handholes.
   3. Underground pull boxes.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with manholes and handholes in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

B. Manufacturer Qualifications: Manufacturers of precast manholes and handholes shall be firms regularly engaged in manufacturing factory-fabricated manholes and handholes, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and material certification as required.

B. Submittals: Submit the following in accordance with Conditions of Contract and Division 01 specification sections.
   1. Product data for accessories for manholes and handholes and miscellaneous components include:
      a. Frames and covers.
      b. Pulling eye assemblies.
      c. Pulling and lifting hardware.
      d. Bolting inserts.
      e. Cable stanchions, arms, and insulators.
      f. Sump frames and cover.
      g. Manhole ladder.

C. Reference Submittals: Detail drawings and design calculations for precast manholes and handholes, including reinforcing steel. Drawings shall bear the stamp of a registered professional structural engineer.

1.5 JOB CONDITIONS

A. Existing Utilities: Information on underground utilities and possible obstructions in the path of construction under this section was obtained through investigations during the design of the project. This information is not intended as representations or warranties of accuracy regarding conditions and locations. The Owner will assume no responsibility of interpretations or conclusions drawn from this information.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

B. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 DEFINITIONS

A. Manhole: A below-the-surface enclosure or chamber, large enough for a person to enter, connecting with ducts, and affording facilities for installing, operating, and maintaining equipment or wiring.

B. Handhole: A below-the-surface enclosure in connection with ducts into which people reach, but do not enter, for the purpose of installing, operating, or maintaining equipment or wiring.

C. Underground Pull Box: A below-the-surface bottomless enclosure in connection with ducts into which people reach, but do not enter, for the purpose of installing, operating, or maintaining equipment or wiring.

1.8 SEQUENCING AND SCHEDULING

A. Coordination of the Work: Coordinate layout and installation of manholes and handholes with final arrangement of ducts as influenced by actual final location of other utilities in the field. Coordinate elevations of duct and raceway entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to manholes and handholes and as approved by the A/E.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Precast Manholes and Handholes
1. Factory fabricated of reinforced concrete and in conformance with American National Standards Institute (ANSI) C 2, "National Electrical Safety Code (NESC)" and applicable requirements of American Society of Testing Materials (ASTM) C 478, "Specifications for Precast, Reinforced Concrete Manhole Sections." Manhole structure shall be designed

in accordance with requirements of the American Association of State Highway and Transportation Officials (AASHTO) publication "Standard Specifications for Highway Bridges." AASHTO H20 highway loading shall apply with 30% loading added for impact.

2. Handholes, unless otherwise indicated, shall be 4 feet W x 4 feet L x 4 feet D and shall be constructed of precast concrete in two sections. The reinforced concrete shall utilize Grade 60 reinforcing bars and Type II cement with a concrete strength equal to 4,500 pounds per square inch (psi).
3. Manholes, unless otherwise indicated, shall be 6 feet W x 8 feet L x 6 feet D and shall be constructed of precast concrete in two sections. The reinforced concrete shall utilize Grade 60 reinforcing bars and Type II cement with a concrete strength equal to 4,500 psi.
4. Precast units consisting of interlocking, mating sections, complete with accessory items, hardware, and features as indicated, including concrete knockout panels for conduit entrance and sleeve for ground rod.
5. Joint sealant for joints between precast sections shall be continuous extrusion of asphaltic butyl material compounded for the adhesion, cohesion, flexibility, and durability properties required for a permanent seal against the maximum hydrostatic pressures theoretically attainable at the installation location with the ground water level at grade.

B. Manhole/Handhole Hardware and Accessories

1. Frames and covers shall be cast iron conforming to American National Standards Institute (ANSI) C2, "National Electrical Safety Code," Rule 323. Furnish with cast-in legend, "Electric" or "Signal" as appropriate. Cover to frame bearing surfaces machined.
2. Sump frame and grate shall comply with PS RR-F 621, Type VII for frame, Type I for cover. Locate sump at center of manhole or handhole directly below the cover.
3. Pulling eyes in walls shall be eyebolt with rebar fastening insert. Two-inch-diameter eye, 1-inch x 4-inch long bolt. Working load embedded in 6-inch, 4,000 pounds per square inch (psi) concrete: 13,000 pounds minimum tension.
4. Pulling and Lifting Irons in Floor shall be 7/8-inch diameter hot-dipped galvanized, bent steel rod, stress-relieved after forming, and fastened to reinforced rod. Exposed triangular shaped opening. Ultimate yield strength, 40,000 pounds shear, 60,000 pounds tension.
5. Bolting inserts for cable stanchions shall be flared, threaded inserts of non-corrosive, chemical-resistant, non-conductive thermoplastic material. One-half-inch internal diameter by 2-3/4 inches deep, flared to 1-1/4-inch minimum at base. Tested ultimate pull-out strength: 12,000 pounds, minimum.
6. Expansion anchors for installation after concrete is cast shall be zinc-plated carbon steel wedge-type with stainless steel expander clip 1/2-inch bolt size, 5,300-pound-rated pull-out strength, and 6,800-pound-rated shear strength, minimum.
7. Barriers shall be provided for voltage separation of electrical, telephone, and instrumentations cables.
8. Cable stanchions shall be hot-rolled, hot-dipped galvanized "T" section steel, 2 1/4-inch size, punched with 14 holes on 1-1/2-inch centers for cable arm attachment.
9. Cable arms shall be 3/16-gauge hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two 12 inches wide x 14 inches long and arranged for secure mounting in horizontal position at any position on cable stanchions.
10. Cable support insulators shall be high-glaze, wet-process porcelain arranged for mounting on cable arms.

C. Underground Pull Boxes
   1. Underground pull boxes shall be factory-fabricated of fiberglass-reinforced polymer concrete. Boxes shall be stackable with minimum dimensions 17 inches W x 30 inches L x 12 inches D.
   2. Covers: Provide heavy-duty covers rated for a service load of 15,000 pounds over a 10-inch-square area. Covers shall read either "Electric," "Telephone," or "Signal," depending on the application. Covers shall be secured with stainless steel penta-head bolts.
   3. Openings: Openings shall be provided for duct number and size as indicated on plan.
   4. Underground pull boxes shall be Quazite type "PC" or equal.

D. Manhole and Handhole Moisture Proofing: Conform to Division 07 for waterproofing.

E. Ladder: Fiberglass manhole ladder, specifically designed for electrical manhole use. Minimum length equal to the distance from the deepest manhole floor to grade, + 3 feet.

F. Raceway/Duct Sealing Compound: Compound shall be non-hardening, putty-like consistency, workable at temperatures as low as 35 deg F. Compound shall not slump at a temperature of 300 deg F, and shall readily adhere to clean surfaces of plastic ducts, metallic conduits conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals. Compound shall have no injurious effect on worker's hands and on materials.

G. Extra Materials
   1. Furnish the following extra materials matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.
   2. Cable stanchions, support arms, insulators, and associated fasteners in the quantity of 10% of those installed for actual use in this project.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include the following:
   1. Precast Manholes, Handholes, and Underground Pull Boxes.
      a. CDR Systems Corporation.
      b. Christy Concrete Products, Inc.
      c. Elrnhurst-Chicago Stone Co.
      d. Hartford Concrete Products, Inc.
      e. Norwalk Concrete Industries.
      f. Quazite Corporation.
      g. Rotondo/Penn-Cast, Inc.
      h. Smith-Midland Corp.
      i. Utility Vault Co.
      j. Wausau Concrete Co.
      k. Or equivalent.
   2. Frames and Covers
      a. East Jordan Iron Works, Inc.
      b. Campbell Foundry Co.
      c. McKinley Iron Works.
      d. Neenah Foundry Co.
      e. Or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Duct Entrances to Manholes and Handholes: End bells spaced approximately 10 inches center to center for 5-inch ducts and varied proportionately for other duct sizes. The change from regular spacing to end bell spacing shall start 10 feet from the end bell and shall be made without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole and handhole walls from both sides to provide watertight entrances.

B. General: Provide manholes, handholes, and underground pull boxes of sizes, shapes, and locations as indicated. Determine final grading of ducts as influenced by possible adjustments in other utilities and surface features and discovery of underground obstructions before installing manholes, handholes, and underground pull boxes. Obtain A/E's approval for manhole, handhole, and underground pull box installation adjustments necessitated by the above. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

C. Elevation: Install manholes and handholes with rooftop 15 inches below finished grade, minimum. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 1 inch above grade.

D. Drainage: Install drains in bottom of units where indicated. Arrange to coordinate with drainage provisions indicated or specified.

E. Precast Access: Install access to manhole/handhole through cast iron frame and cover. For manholes and handholes, use 30-inch-diameter cover, except as indicated. Install precast concrete rings and seal with joint sealant as described in Part 2 of this specification. In addition, caulk all seams and joints inside and out. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch above finished grade.

F. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. Apply in accordance with requirements of Division 07. After ducts have been connected and grouted in, and prior to backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole/handhole chimneys after brick mortar has cured at least 3 days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators as required for installation and support of cable and conductors and as indicated.

H. Field Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

I. Install barriers for voltage separation of electrical, telephone, and instrumentation cables.

J. Grounding: Ground manholes, handholes, and underground pull boxes in accordance with Division 26 Section “Grounding”.

3.2 INSTALLATION OF PRECAST MANHOLES, HANDHOLES AND UNDERGROUND PULL BOXES

A. Install in accordance with ASTM C 891, "Practice for Installation of Underground Precast Concrete Utility Structures," and manufacturer's instructions.

B. Support units on a minimum 4-inch-deep level bed of crushed stone or gravel, graded from the 1-inch sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Compact backfill as required to set units securely in place. Backfill and grading shall be sloped to drain surface water away from access covers.

3.3 FIELD TESTING

A. Grounding: Test grounding provisions to ensure electrical continuity of bonding and grounding connections. Make ground resistance test at each ground rod and submit a report of the results. Use an instrument specifically designed for ground resistance measurements.

B. Watertightness: Make internal inspection of manholes/handholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove any water found and seal leakage sources. Reinspect after 2 months and reseal any remaining leakage sources. Repeat process at 2-month intervals until leakage is corrected.

3.4 CLEANING AND RESTORATION

A. Clean Manholes: Clean all internal surfaces of manholes, including sump. Remove all foreign material.

END OF SECTION 26 0543

SECTION 26 0553

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to perform the work in accordance with the plans and as specified herein.

B. This section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
   1. Buried electrical line warnings.
   2. Identification labeling for raceways, cables, and conductors.
   3. Operational instruction signs.
   4. Warning and caution signs.
   5. Equipment labels and signs.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with electrical identification in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

B. Electrical Component Standard: Components and installation shall comply with National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."

C. American National Standards Institute (ANSI) Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

1.4 DEFINITIONS

A. Abbreviations
   1. AHJ: Authority having jurisdiction.

1.5 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required

B. Provide submittal for approval of format, descriptions, and contents prior to fabrication.

C. Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for each type of product specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Box, Conduit, and Raceway Identification
   1. Adhesive Labels: Preprinted, flexible, self-adhesive orange vinyl labels with black legend. Legend covered with clear weather and chemical resistant coating.
   2. Plastic Sleeves: Preprinted, pretensioned, snap-on, flexible, wraparound plastic sleeves with black legend. Sized to fit conduit diameter.
   3. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
   4. Buried Line Warning Tape: Permanent, bright colored, continuous printed, plastic warning tape not less than 6 inches wide by 4 mils thick with continuous metallic strip or core. Printed legend indicative of general type of underground line below.

B. Wire and Cable Identification
   1. Colored Marking Tape: Self-adhesive vinyl tape not less than 7 mils thick and 3/4 inch wide.
   2. Wire Labels: Self-adhesive wraparound labels with clear heat shrinkable jacket or permanent plastic heat shrinkable labels. Preprinted legends.

C. Nameplates and Signs
   1. Laminated Plastic: Engraving stock plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Engrave legend in black letters on white face unless otherwise noted and punched for mechanical fasteners.
   2. Metal Backed Butyrate: Weather resistant, nonfading, preprinted cellulose acetate butyrate signs with 20 gauge, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4 inch grommets in corners for mounting.
   3. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fasteners. Dimensions: 2 inches by 2 inches by 19 gauge.

D. Accessories
   1. Fasteners: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
   2. Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking nylon cable ties, 0.18 inch minimum width, 50 pound minimum tensile strength, and suitable for a temperature range from minus 40 degrees Fahrenheit (° F.) to 185° F. Provide ties in specified colors when used for color coding.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
   1. American Labelmark Co.; Labelmaster Subsidiary
   2. Brady USA, Inc.; Industrial Products Div.
   3. Calpico, Inc.

4. Carlton Industries, Inc.
5. Champion American, Inc.
6. Cole-Flex Corp.
7. D&G Sign and Label.
8. Emed Co., Inc.
9. George-Ingraham Corp. (The)
10. Grimco, Inc.
11. Ideal Industries, Inc.
12. Kraftbilt.
13. LEM Products, Inc.
14. Markal Corp.
15. National Band and Tag Co.
16. Panduit Corp.
17. Radar Engineers.
18. Ready Made Sign Co.; Cornerstone Direct Corp. Div.
19. Seton Name Plate Co.
20. Standard Signs, Inc.
21. W. H. Brady, Co.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conduits
1. Underground Lines: Identify with warning tape in trench above conduits.

B. Boxes
1. Code Required Caution Signs: Self-adhesive labels indicating system voltage. Install on outside of box cover.
2. Circuit Identification: Self-adhesive labels indicating contained circuits.

C. Wires and Cables
1. Color Coding
a. Color code service, feeder, and branch circuit conductors as follows:

208/120 Volts	**Phase**	**480/277 Volts**
Black	A	Brown
Red	B	Orange*
Blue	C	Yellow
White	Neutral	White
Green	Ground	Green
*Where not permitted by inspecting authority, use purple.		

b. Use conductors with color factory applied for sizes No. 8 AWG and smaller.
c. Use colored marking tape for sizes larger than No. 8 AWG. Apply for a distance of 6 inches from terminal points and in boxes where splices or taps are made.

2. Circuit Identification: Use aluminum wraparound marker bands to identify feeders and branch circuits in manholes, handholes, and pull boxes.
3. Conductor Labeling: Use wire labels to identify conductors as follows:
   a. Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
   b. Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three circuit, four wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation.
   c. Label all control, communication, signal, and metering conductors with wire numbers matching the numbers on the approved shop drawings from the system integrator.
   d. Match identification markings with designations used in panelboards, shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
   e. Provide securely attached nameplates identifying all ground buses. Provide securely attached nametags to each accessible termination, attachment, or bonding location for each equipment grounding conductor, grounding electrode conductor, and bonding conductor.

D. Signs
1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to ensure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. For emergency operating signs, install engraved laminate signs with white legend on red background with minimum 3/8 inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
3. Provide code required signs for multiple main switches, for standby power systems, and, where required, for generator ground connection.

E. Nameplates
1. General: Provide equipment identification nameplates for each major unit of electrical equipment, including central or master units of each electrical system. This includes communication/signal/alarm systems unless unit is specified with its own self-explanatory identification. Text shall match terminology and numbering of the contract documents and shop drawings.
2. Provide 1-1/2 inch high engraved plastic laminated nameplates (2 inches high where two lines of text are required) with 1/2 inch lettering for the following:
   a. Panelboards, electrical cabinets, and enclosures.
   b. Switchboards.
   c. Motor control centers.
   d. Motor starters.
   e. Power transfer equipment.
   f. Contactors.

g. Transformers.
h. Enclosed circuit breakers.
i. Disconnect switches.
j. Control panels.

3. Provide 5/8 inch high engraved plastic laminated nameplates (1 inch high where two lines of text are required) with 1/4 inch high lettering for individual compartments of the following:
   a. Switchboards.
   b. Motor control centers.
4. Provide 5/8 inch high engraved plastic laminated nameplates (1 inch high where two lines of text are required) with 1/4 inch high lettering for the following:
   a. Control stations.
   b. Control devices.
   c. Light switches.
5. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. All code requirements for signage shall be met.

3.2 INSTALLATION

A. General
   1. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
   2. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC. Clean surfaces of dust, loose material, and oily films before applying.
   3. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
   4. Install labels where indicated or at locations for best viewing without interference with operation and maintenance of equipment.

B. Buried Line Warning Tape: During trench backfilling, for exterior underground power, control, signal, and communications cables and conduits, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.

C. Tape: Apply colored, pressure sensitive plastic tape in half-lapped turns. Apply the last two turns of tape with no tension to prevent possible unwinding. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

D. Metal Tags: Attach metal tags with one piece self-locking nylon cable ties.

E. Cable Ties: Apply cable ties with a special tool or pliers; tighten for snug fit and cut off excess length.

END OF SECTION 26 0553

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SECTION 26 0573

POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
   1. Short-circuit analysis.
   2. Protective device coordination study.
   3. Arc flash analysis.
   4. Harmonic analysis.

B. Related sections. The following sections contain requirements that relate to this section.
   1. Division 01 section, "Submittal Procedures."
   2. Division 01 section, "Closeout Procedures."
   3. Division 01 section, "Operation and Maintenance Data."
   4. Division 26 section, "Basic Electrical Requirements."
   5. Division 26 section, "Basic Electrical Materials and Methods."

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. National Fire Protection Association (NFPA)
   1. NFPA 70 – The National Electrical Code.
   2. NFPA 70E Standard for Electrical Safety in the Workplace.

C. American National Standards Institute (ANSI)
   1. ANSI C2, National Electrical Safety Code.

D. Institute for Electrical and Electronics Engineers (IEEE)

1.4 DEFINITIONS

A. Abbreviations
   1. AHJ. Authority having jurisdiction.
   2. NRTL. Nationally recognized testing laboratory.

1.5 SYSTEM DESCRIPTION

A. Electrical system description.
   1. The studies shall include all portions of the electrical distribution system necessary to ensure that all electrical power components are within their manufacturer’s recommended load and short-circuit ratings, and that all settings and/or sizes are properly coordinated.

The study shall begin at the normal and emergency power sources. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.

2. Electrical service from utility at 15kV.
3. Unit substation to transform from 15kV to 480Y/277V.
4. All downstream distribution and branch panelboards, motor control centers, and significant motor locations.
5. Standby generator and associated emergency power distribution equipment, including automatic transfer switches and generator ground fault protection.
6. Refer to the one line power diagrams.

1.6 SUBMITTALS

A. General.
   1. Comply with the requirements of Division 01 section, "Submittals."
   2. Manufacturer's literature for software to be used for studies, showing software capabilities applicable to the study to be performed.

B. Report of the Power System Study.
   1. Submit the report simultaneously with the protective equipment.
   2. Equipment submittals will not be approved without the completion and review of the power systems study.
   3. Summarize the results of the power system study.
   4. Include the one line diagram.
      a. Transformer rating, voltage ratio, impedance, and winding connection.
      b. Feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.
      c. Switchgear, switchboards, panelboards, motor control centers, fuses, circuit breakers, automatic transfer switches and switches continuous current ratings.
      d. Protective relays with appropriate device numbers and current transformers and potential transformers with associated ratios.
      e. Detailed legend indicating device type identification and other significant details.
   5. Include tables equipment ratings versus calculated short circuit values and X/R ratios.
   6. Protective device coordination plots.
   7. Tables of protective device settings and fuse selection.
   8. Engineering analysis, commentary and recommendations.

C. Quality Control Submittals
   1. Submit qualification data for firms and persons performing the study.
   2. Include list of completed projects with project names, addresses, names of A/E and Owner, and other information specified.

1.7 QUALITY ASSURANCE

A. Preparer's Qualifications
   1. Experienced in the analysis, evaluation, and coordination of electrical distribution systems similar to the system for this project.
   2. Minimum of one million dollars of Professional Liability Insurance in addition to standard general insurance.
   3. Minimum of five years experience in the analysis, evaluation, and coordination of electrical distribution systems.

4. Study prepared, signed, and sealed by a Professional Engineer registered in the State of Ohio.

B. Regulatory requirements: Comply with the following:
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

1.8 SEQUENCING AND SCHEDULING

A. Sequencing.
1. Studies must be completed prior to final approval of the electrical distribution equipment shop drawings.
2. Equipment must not be released for manufacturing until study has been submitted and reviewed.

PART 2 - PRODUCTS

2.1 PREPARERS

A. Preparers. Subject to compliance, select one of the following companies to perform the specified studies:

B. Available preparers. Companies available to perform the specified studies include but are not limited to the following:
1. General Electric Industrial Systems, Columbus, OH 614-899-8923.
2. High Voltage Maintenance, Dayton, OH 937-278-0811.
3. Pahl Engineering, Mansfield, OH 419-756-8430.
4. Cutler-Hammer, Columbus, OH 614-899-4105.

2.2 SHORT-CIRCUIT ANALYSIS

A. General.
1. Have the report prepared and stamped by a Registered Professional Engineer that specializes in power system studies.
2. Base the report upon the actual equipment installed under the Contract.
3. Provide all information required to complete the study.
4. Obtain the available fault current from the local utility
5. Submit three copies of the report prior to project closeout.
6. Perform the study using recognized electrical analysis software meeting the calculation requirements of ANSI C.37 and IEEE Std. 399.

B. Report. As a minimum, provide the following:
1. One-line power diagram of the electrical system showing the following:
a. All electrical equipment and wiring protected by the overcurrent devices
b. Available short circuit current from the electric utility.
c. Short circuit current contributions from each motor.
d. Calculated fault impedance, X/R ratio, short circuit current and ground fault current for the following:
1) Each bus.
2) Every feeder.
e. Momentary and interrupting ratings for each overcurrent protective device.

f. Fault withstand ratings of all distribution equipment.
g. Capacity, voltage, impedance, X/R ratios, and wiring connections for all transformers.
h. Voltage at each bus.
i. Identification of each bus.
j. Conduit material, feeder sizes, length, and X/R ratios.

2. Overcurrent protective device time-current and short circuit curves.
3. Table showing the following information for each overcurrent protective device:
   a. Device identification and load controlled.
   b. Type of device.
   c. Operating voltage
   d. Interrupting current rating
   e. Calculated short circuit current
4. Fault Analysis
   a. Analyze the short circuit calculations.
   b. Highlight any equipment that is underrated as specified.
   c. Propose approaches to effectively protect the underrated equipment.
   d. Recommend modifications required to conform with the study.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. General.
1. Have the report prepared and stamped by a Registered Professional Engineer that specializes in power system studies.
2. Base the report upon the actual equipment installed under the Contract.
3. Provide all information required to complete the study.
4. Submit three copies of the report prior to project closeout.
5. Perform the study using commercially available electrical analysis software.

B. Report. As a minimum, provide the following:
1. Overcurrent protective device time-current and short circuit curves.
2. Table showing the following information for each overcurrent protective device:
   a. Device identification and load controlled.
   b. Type of device.
   c. Operating voltage
   d. Interrupting current rating
   e. Calculated short circuit current
3. Overcurrent protective device settings table with the following information:
   a. Device identification and load controlled.
   b. Fuse rating and type.
   c. Circuit breaker trip rating or rating plug.
   d. Circuit breaker long time, short time, and instantaneous settings.
   e. Ground fault pickup and time delay settings.
   f. Relay CT ratios and protection setpoints for electronic relays.
   g. Relay curve selection.
4. Coordination plots.
   a. Plot the protective device time-current characteristics
   b. Use a logarithmical scale for both time and current.
   c. Provide a separate sheet for the largest branch circuit protective device connected each bus.
   d. Show the following information on the same sheet:

1) Curves for all upstream devices including the service equipment.
2) ANSI damage point for each transformer.
3) Device identification.
4) Voltage and current ratios for curves.
5) Minimum melt and total clearing curves for fuses.
6) Cable damage curves.
7) Transformer inrush points
8) Total connected kVA inrush for feeder circuits.
9) Maximum short circuit cutoff point

5. Coordination Analysis
   a. Highlight areas lacking coordination.
   b. Provide a technical evaluation with a discussion of the logical compromises for best coordination.

C. Certification.
1. Certify that the protective devices have been adjusted and set in accordance with the approved protective device coordination study.
2. Prior to final acceptance, provide four copies of a certificate signed by the preparer.

2.4 ARC FLASH HAZARD STUDY

A. Calculate the short circuit fault current levels and protective device settings feeding switchboards, panelboards, industrial control panels, and motor control centers.

B. Calculate the following:
1. Flash hazard boundary
2. Amount of incident energy
3. Shock hazard
4. Limited approach distance
5. Restricted approach distance
6. Prohibited approach distance
7. Type of personnel protective equipment (PPE) needed.

C. Provide colored custom stick-on labels for each switchboard, panelboard, industrial control panel, and motor control center.
1. Label shall be 3”x5”, have rounded corners, thermal transfer type of high adhesion polyester – chemically resistant and suitable for UV. No hand marking on label. Label shall comply with ANSI Z535.4-2011 Product Safety Signs and Labels. If equipment front face is not large enough to accommodate arc flash label, use an approved plastic backing for the label and use a nylon tie-wrap to tie the arc flash label to the incoming conduit.
2. Each label must have the following information:
   a. Arc flash hazard boundary.
   b. Calories per square centimeter at 36 inches.
   c. Personnel protective equipment (PPE) required.
   d. Voltage of Shock Hazard when cover is removed.
   e. Distance for limited approach.
   f. Distance for Restricted Approach.
   g. Distance for Prohibited Approach.

D. Comply with NEC Article 110.16 and NFPA 70E

E. Comply with IEEE Standard 1584-2002, Guide for Arc Flash Hazard Analysis when performing the arc flash analysis.

2.5 HARMONICS ANALYSIS

A. The harmonic analysis shall be performed by a computer aided circuit simulation of the distribution system specific to this project. These calculations shall show that the total harmonic voltage distortion shall be less than 5 percent due to the contribution of all VFD's supplied.

2.6 COMPONENTS

A. Short-circuit and protective device evaluation and coordination study.
   1. The short-circuit study shall be performed with the aid of a digital computer program.
   2. In the short-circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.
   3. In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, 8 1/2 x 11 log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
   4. Include on the time-current curve sheets power company relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. In addition, include all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
   5. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.
   6. Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults.

Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.

7. Include complete fault calculations as specified herein based on contract documents.
8. Make all additions or changes as required by the reviewer, after reviewing the reports.
9. Contractor shall obtain all existing sizes and settings for the study by field survey. Data for new equipment shall be obtained from shop drawings.
10. Notify the CMT in writing of existing circuit protective devices not properly rated for fault conditions.
11. When an emergency generator is provided, include phase and ground coordination of the generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Contractor shall obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Perform field adjustments of the protective devices as required to place the equipment in final operating condition.

B. All settings shall be in accordance with the approved short-circuit study and protective device coordination study.

END OF SECTION 26 0573

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SECTION 26 0900

CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
   1. Pilot devices (push buttons, pilot lights, etc.).
   2. Elapsed time meters.
   3. Relays and timers.
   4. Intrinsically Safe Relays.
   5. Zener Barriers.
   6. Sensing devices (limit switches, proximity switches, etc.).
   7. Alarms and signals.

B. Related Sections
   1. Division 01 section, "Submittal Procedures."
   2. Division 01 section, "Operation and Maintenance Data."
   3. Division 26 Section “Electrical Identification”.

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. Underwriter's Laboratory (UL)

C. National Electrical Manufacturers Association (NEMA)

D. National Fire Protection Association (NFPA)

E. American National Standards Institute (ANSI)

F. Institute for Electrical and Electronics Engineers (IEEE)

G. The Instrumentation, Systems, and Automation Society (ISA)

H. American Society for Testing and Materials (ASTM)

1.4 DEFINITIONS

A. Abbreviations
   1. AHJ: Authority having jurisdiction.
   2. DPDT: Double pole double throw.
   3. NRTL: Nationally recognized testing laboratory.

4. SPST: Single pole single throw.
5. SPDT: Single pole double throw.

B. Finished Locations: For the purposes of this specification, the following are finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: For the purposes of this specification, the following are interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: For the purposes of this specification, the following are wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: For the purposes of this specification, the following are corrosive locations.
1. All locations with chemical feed/transfer equipment, chemical storage tanks, or chemical storage drums are located.

F. Hazardous (Classified) Locations
1. Hazardous (classified) locations as defined by the NEC.
2. Hazardous locations and their classification are shown.

1.5 SUBMITTALS

A. General
1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
2. Provide all information necessary to determine compliance with the plans and specifications.

B. Product Data
1. Manufacturer’s technical product data sheets for all products specified in this section.
2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
1. Wiring Diagrams: Submit wiring diagrams for all products.
a. Show all components and features specified.
b. Differentiate between factory and field installed wiring and components.

D. Contract Closeout Submittals: Operation and maintenance (O&M) data.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.
   3. All units of the same type must be from the same manufacturer.

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Provide products listed and labeled by an approved independent NRTL.
   3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 PILOT DEVICES

A. General
   1. Round, heavy-duty, 30.5 mm.
   2. NEMA rated equal to enclosure.
   3. 5 amp NEMA B600 sealed contacts.
   4. Type and quantity of contacts as shown on drawings.

B. Push Buttons
   1. Momentary contact.
   2. Extended head
   3. Color as shown on drawings or specified in other specification sections.

C. Emergency Stop Push Buttons
   1. Maintained contact
   2. Push/pull operator
   3. 2-1/4 inch diameter mushroom head
   4. Red.

D. Selector Switches
   1. Maintained contact, unless otherwise shown.
   2. Number of positions as shown on drawings.

E. Cylinder Lock Operator
   1. Push button or selector switch type as shown on drawings.
   2. Operable only with key in lock.
   3. Provide two keys.

F. Pilot Lights
   1. Push-to-test LED type.
   2. Lens and lamp color as shown on drawings.

G. Legend Plates
   1. Extra large size
   2. Engraved laminated plastic
   3. Color
      a. Normal: Black legend on white background
      b. Emergency stop: Black legend on red background.

H. Accessories: Provide the following accessories where shown on the drawings.
   1. Padlocking Cover. Pad-lockable cover to prevent operation of pilot device.
   2. Protective Boot. Flexible plastic designed to prevent entrance of foreign materials.

I. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Allen Bradley Company.
   2. Cutler Hammer.
   3. Square D Company.

2.3 ELAPSED TIME METERS

A. General: 120 volt, synchronous motor driven, mechanical register indicating up to 99,999.9 hours.

B. Window Kit: Type 304 stainless steel frame, brushed finish, polycarbonate window, oil resistant gasket, NEMA 4X rated.

C. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Cramer Company.
   2. Hobbs.
   3. Industrial Timer Company.
   4. Redington Counters, Inc.
   5. Syrelec/Crouset Corporation.
   6. Weschler.

2.4 RELAYS AND TIMERS

A. General Purpose Relays: General purpose, plug in, tube base, transparent polycarbonate housing, 3PDT, 10 amp contact rating, coil voltage as shown on drawings.

B. General Purpose Timing Relays: General purpose, plug in, tube base, solid state, DPDT, 10 amp contacts, switch selectable timing mode (on delay, off delay, repeat cycle), switch selectable timing range (up to 10 hours). Voltage rating as shown on drawings.

C. Power Relays: DPDT, 30 amp, 1-1/2 horsepower rated contacts, coil voltage as shown on drawings.

D. Alternators: Two load alternator, plug in, tube base, 10 amp contact rating, DPDT cross connected, solid state alternating circuit, load 1-alternate-load 2 selector switch, voltage rating as shown on drawings.

E. Mounting Sockets: Surface mounted, tube base, screw terminals, with retaining strap.

F. Shall include a LED and mechanical visual indicator to indicate relay is energized.

G. Shall include push-to-test-pull-to-lock button manual operator.

H. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:

1. Allen Bradley Company.
2. Cutler Hammer.
3. Furnas Electric Company.
4. General Electric Company.
5. Potter and Brumfield, Inc.
6. Releco.
7. Square D Company.
8. SSAC, Inc.
9. Time Mark Corporation.

2.5 INTRINSICALLY SAFE RELAYS

A. Type: Dual or single channel transformer type intrinsic safety barrier with built-in amplifier.

B. Power: 120VAC, 50-60Hz.

C. Power Consumption: 10VA maximum.

D. Input: Isolated from output and supply.

E. Output: Relay type SPST 2A/250V.

F. Mounting: DIN rail.

G. Operation Temperature: -45 deg F to + 131 deg F.

H. State Mode of Operation: Switch selectable each channel.

I. Fault Monitoring: LED indicator each channel (lead breakage).

J. Output Status Monitoring: LED indicator each channel.

K. Approvals:
1. UL Listed or recognized component.
2. Approved for providing intrinsically safe circuits for use in Class I, Div. 1 Hazardous Locations.

L. Manufacturers:
1. Pepperl and Fuchs.
2. Phoenix Contact.
3. Or approved equal.

2.6 ZENER BARRIERS

A. Type: Dual channel zener barriers which accept 24Vdc field transmitter inputs and limit hazardous area energy to levels below that which could ignite a specific gas/air mixture.

B. Working Voltage: 27Vdc.

C. Maximum Voltage: 28Vdc.

D. Mounting: DIN rail.

E. Approvals: FM approved for Class I, Div. 1, Group D areas.

F. Operation Temperature: -45 deg F to + 131 deg F.

G. Manufacturers:
1. Pepperl and Fuchs.
2. Phoenix Contact.
3. Or approved equal.

2.7 SENSING DEVICES

A. Limit Switches.
1. NEMA 4X.
2. Four operating head mounting positions.
3. DPDT contacts, momentary.
4. Operating head style: As required per installation location.
5. Stainless steel operating lever.

B. Proximity Sensors.
1. Inductive, shielded type.
2. Stainless steel housing, 30 mm cylindrical.
3. NEMA 4X, unless otherwise noted.
4. Normally open contact.
5. Voltage rating as shown on drawings.

C. Door Switches.
1. Two piece, surface mount.
2. Magnet assembly for mounting on the door.
3. Magnetically actuated reed switch assembly for mounting on the door jamb.
4. Normally open contact, 24 VDC.

D. Manufacturers. Subject to compliance, provide products manufactured by one of the following:

E. Available Manufacturers. Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
1. Allen Bradley Company.
2. Cutler Hammer.
3. Edwards.
4. Furnas Electric Company.
5. General Electric.
6. Simplex.
7. Square D Company.

2.8 ALARMS AND SIGNALS

A. Horns.
1. Vibrating diaphragm type.
2. Minimum sound output of 100 decibels (dB) at 10 feet.
3. Enclosure. NEMA 4X, with matching mounting box.
4. Voltage rating. 120 VAC, unless otherwise shown.

B. Warning Lights.
   1. Rotating sealed beam type.
   2. Incandescent lamp, 100 watt.
   3. NEMA 4X cast aluminum housing.
   4. Lexan dome color as shown on plans.
   5. Voltage rating. 120 VAC, unless otherwise shown.

C. Strobe Lights.
   1. High intensity strobe, 100,000 candlepower minimum.
   2. Self-contained power supply.
   3. NEMA 4X cast aluminum housing.
   4. Lexan dome color as shown on plans
   5. Voltage rating. 120 VAC, unless otherwise shown.

D. Manufacturers. Subject to compliance, provide products manufactured by one of the following:

E. Available Manufacturers. Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Benjamin Division, Thomas Industries.
   2. Federal Signal Corporation.
   3. Maxi Signal Products, Division of MV Specialties.

2.9 TERMINAL BLOCKS

A. General: NEMA style, rail mounted, tin-plated copper, screw type with pressure plate, 600 volt rated, wire range No. 22 to No. 8 American Wire Gauge (AWG).

B. Fuse Blocks: Integral fuse puller and blown fuse indicator.

C. Isolating Blocks: Knife style.

D. Accessories
   1. Mounting rail.
   2. End barriers and end anchors.

E. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Allen Bradley Company.
   2. Buchanan.
   3. Cutler-Hammer Products.
   4. Phoenix Contact.
   5. Square D Company.

2.10 CONTROL POWER TRANSFORMERS

A. General: Copper windings, vacuum impregnated, open type, 480 volt primary and 120 volt secondary unless otherwise shown, with top mounted fuse block.

B. Available Manufacturers: Subject to compliance, available manufacturers of products specified include, but are not limited to, the following:
   1. Allen Bradley Company.

2. Cutler-Hammer Products.
3. Heavy Duty.
4. Square D Company.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
1. Inspect installed work prior to performing the work of this section.
2. Verify that the project has progressed to a point where this installation may begin.

B. Discrepancies
1. Immediately notify the Engineer in writing if any discrepancies are found.
2. Resolve all discrepancies before proceeding with installation.
3. Resolution must be acceptable to the Engineer.

3.2 PREPARATION

A. Surface Preparation
1. Carefully lay out the work in advance.
2. Perform any cutting , drilling, etc. without damaging the building surfaces or equipment.

B. Rough-In
1. Refer to equipment submittals for rough-in requirements.
2. Verify rough-in locations by field measurements.

3.3 INSTALLATION OF CONTROL DEVICES

A. General.
1. Install in accordance with manufacturer's written instructions.
2. Follow applicable requirements of National Electrical Contractors Association's (NECA) "Standard of Installation."
3. Coordinate with other work, including painting.
4. Install control devices only in boxes that are clean and free from dirt and debris.
5. Install control and indicating devices after wiring work is completed.
6. Install control devices in enclosures as required under other sections and as shown.
7. Tighten connectors and terminals to manufacturer's published torque tightening values.
8. Where manufacturer's torque requirements are not indicated, comply with UL 486A.

B. Grounding
1. Provide equipment grounding connections for control and indicating devices.
2. Tighten connection to comply with tightening torque specified in UL Standard 486A.

3.4 TESTING

A. General.
1. Prior to energizing circuitry, test control stations for electrical continuity.
2. After completion, demonstrate capability and compliance with project requirements.

END OF SECTION 26 0900

SECTION 26 2000

POLYPHASE INTEGRAL HORSEPOWER MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall provide all labor, materials, equipment and incidentals required to provide polyphase integral horsepower motors as shown on the Drawings, specified or required. This electric motor specification describes minimum requirements for motors furnished as part of driven equipment specified under other Sections.

1.3 REFERENCES

A. Reference Standards:
   1. NEMA MG 1, Motors and Generators
   2. Anti-Friction Bearing Manufacturers Association (AFBMA), Standards
   3. NFPA 70, National Electrical Code (NEC)

1.4 SYSTEM DESCRIPTION

A. Refer to the Specification Section for the driven equipment.

B. Motors shall be suitable for installation in Wet and Corrosive conditions, unless otherwise noted.

1.5 SUBMITTALS

A. Submittals for motors shall accompany the submittals for the driven equipment specified in other Sections. Submittals for motors that are not associated with equipment specified in other Sections shall be submitted under this Section.

B. Shop Drawings:
   1. Shop Drawings shall be certified.
   2. Motor wiring diagrams shall include optional internal devices and accessories and wire identification numbers.
   3. Copy of Manufacturer's instructions for storage, handling, and installation.
   4. Performance curves and data, for each motor, showing the starting, accelerating, and running characteristics, including: Current in amperes, torque in pound-feet, output hp including initial hp if motor was derated, speed in revolutions per minutes and first-half cycle inrush current at stated design point.
      a. Motors up to 100 hp: Provide performance curves and data for typical motor.
      b. Motors above 100 hp: Provide performance curves and data for each individual motor.

5. Motor Data Sheet:

MOTOR EQUIPMENT NO. *	PROJECT FILE NO.
1. Hp (if motor is derated also indicate initial motor hp)	
2. Voltage (V)	
3. Phase	
4. Hertz (Hz)	
5. Type (sq. cage, sync, etc.)	
6. Manufacturer	
7. rpm – full load	
8. Enclosure	
9. Ambient temperature (F or C)	
10. Current – No Load (A)	
11. Current – Full Load (A)	
12. Current – Locked Rotor (A)	
13. Inrush current at stated design point	
14. NEMA frame size	
15. Mounting (Horiz., Vert.)	
16. Insulation Class	
17. Rotation	
18. Bearing Type	
19. Duty Cycle	
20. Service factor	
21. NEMA design	
22. NEMA efficiency index code	
23. kVA code	
24. Special modifications	

Oversize conduit box
Space heater (watts) 120VAC
Motor winding thermal protection switch or contact noted 120VAC
*If data is for more than one motor, list equipment numbers and quantity involved.

C. Product Data:
1. Manufacturer's literature, illustrations, specifications and engineering design data including dimensions, materials, size and weight for each motor. Product Data shall be submitted in sufficient detail to permit an item-by-item comparison with the requirements of this Section.
2. Motor full-load power factor and maximum capacitor rating where motor and capacitor are switched as a unit.
3. Motor inrush current at stated design point.
4. Certified copies of factory standard test reports
5. Motor first-half cycle inrush current
6. Manufacturer's qualifications

D. Quality Assurance:
1. Factory Test Procedures
2. Factory Test Report
3. Field Test Report
4. Manufacturer's Field Start-up Report

5. Manufacturer's Certification

E. Driven Equipment Witnessed Factory Testing Information:
1. Submittals meeting the requirements of the driven equipment Specification Section shall be provided.

F. Project Record Document Submittals:
1. Submit Project Record Documents: one-line diagram showing the driven equipment designation, the furnished motor hp including motor initial hp if motor was derated, and the furnished motor rpm.

1.6 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer Qualifications: Manufacturer shall be experienced in manufacturing materials and equipment similar to that which is specified herein for at least 5 years with a record of successful in-service performance. When requested, a list of installations in satisfactory operation shall be provided.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Upon delivery at the jobsite, the Contractor shall inspect the motor thoroughly for damage.

B. Handling: The motor shall be lifted in accordance with the manufacturer's instruction. All necessary slings and spreader bars shall be provided by the Contractor. Under no circumstances shall the motor be lifted by using the shaft as an attachment point.

C. Storage: The motor should be installed as soon as possible. If storage is required, the motor shall be stored under cover, inside, in a clean, dry and heated location. If storage is anticipated to be longer than 2 months, the following additional steps shall be taken:
1. The motor space heaters shall be energized.
2. Motors with sleeve bearings shall have the oil reservoirs filled to the proper level with the specified oil.
3. Motors with anti-friction bearings shall receive an initial change of grease and then be re-greased every 6 months.
4. The motor shaft braces shall be removed and the motor shaft rotated every 2 weeks. The shaft braces shall be replaced prior to relocation to the installation site. Under no circumstances shall the motor be lifted without the braces in place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. U.S. Motors – "Corro-Duty"

B. Or approved equal.

2.2 MANUFACTURED UNITS

A. Motors:

1. Motors connected to adjustable frequency drives shall be inverter duty rated and comply with NEMA MG-1, Part 31.
2. Motors shall be premium efficiency.
3. The motors hp rating shall be as indicated on the Drawings.
4. Shall be squirrel cage type, continuous duty, 1800 rpm or 1200 rpm unless otherwise specified in driven equipment specification section.
5. Shall be NEMA Design B, normal starting torque.
6. Shall have a service factor of 1.15 at 40C ambient temperature or a service factor of 1.0 for motors controlled by adjustable frequency drives.
7. Shall be 3-phase, 60Hz with the following voltage ratings:
    a. 1 through 20hp: 230/460V, unless shown on the Drawings or specified otherwise.
    b. 25 through 400hp: 460V
8. Shall have a continuous time rating.
9. Shall be of sufficient size so that there will be no overload on the motor above rated nameplate hp under and condition of operation imposed be the driven equipment.
10. Shall have the following construction:
    a. Enclosures:
        1) Shall be Totally Enclosed Fan Cooled (TEFC) or Totally Enclosed Non-Ventilated (TENV) unless otherwise shown on the Drawings or specified:
            a) Motors above 3hp shall be cooled by means of a shaft-mounted external fan covered with removable guard (TEFC).
            b) Motors 3hp and below may be self-cooled (TENV).
        2) Shall have machined ferrous metal fasteners, castings, and weldments only; no aluminum, other non-ferrous metals, or light gauge sheet metals shall be permitted in motor cases, end bells and tie bolts.
    b. Frames: Shall be cast iron for 182T frames and above or rolled steel for 143T and 145T frames.
    c. Windings: Shall be all copper; no aluminum windings shall be permitted.
    d. Insulation:
        1) Shall be non-hygroscopic.
        2) Shall be Class F materials and construction limited to Class B temperature rise. Motor insulation system shall be given a special varnish treatment for installation in atmospheres containing high concentrations of acid vapor, high relative humidity and excessive moisture. Insulation “U.S. Motors Insulife 2000”.
        3) Windings and Rotor: Shall have an additional coat of non-hygroscopic epoxy varnish.
    e. Main Conduit/Terminal Box:
        1) Shall be cast iron.
        2) Shall be oversized by one size on motors up to 250hp, and oversized by 2 sizes on motors larger than 250hp to allow mounting of auxiliary devices, and ample room for motor leads.
        3) Shall have lead positioning gasket
        4) Shall include a grounding stud connected directly to motor frame.
        5) Boxes shall be designed for rotation in 90 degree steps to receive conduit from any of 4 positions.
    f. Bearings: Shall be double shielded, vacuum degassed bearings with re-greasable fill and corrosion resistant drain plugs. Bearing shall be replaceable. Insulated bearings and shaft grounding shall be provided on each motor 250 hp and larger that is powered from an adjustable frequency drive.
    g. Bearing Life: Shall have a minimum AFBMA L-10 rating:

1) 15,000 hours for belt driven applications
2) 100,000 hours for direct drive applications

h. Shaft Slinger: Shall be neoprene

i. Motor Sound: The sound emanating from a motor shall not exceed the sound power limits of NEMA MG 1.

j. Paint: Corrosion treatment shall consist of anti-rust compounds on metal to metal fits, plated hardware, epoxy painted with manufacturer's standard color paint, including all aluminum parts and air deflectors, with stainless steel nameplates, resin and hardener or equivalent on rotor.

k. Nameplate: Shall be 316 stainless steel. Nameplate shall include:
1) Manufacturer
2) NEMA frame size
3) hp
4) rpm
5) Voltage (V)
6) Full load current (A)
7) Inrush current (A)
8) Hertz (Hz)
9) Service factor
10) NEMA design letter
11) NEMA efficiency index
12) Date code
13) Ambient temperature (F or C)
14) Duty Cycle
15) AFBMA bearing designation
16) Phase
17) Insulation Class
18) kVA code
19) Enclosure type
20) Connection diagram
21) Rotation (if unidirectional)

l. Additional Nameplate: Shall be 316 stainless steel. Nameplate data shall include:
1) Initial hp if motor was derated

m. Options and Accessories: See associated equipment

n. Bolts and Fasteners: Shall be zinc or cadmium plated for corrosion resistance.

o. Construction: Shall be fully gasketed for corrosion resistance.

p. Motor Leads:
1) Shall be stranded copper with non-wicking, moisture-resistant insulation. Leads shall be permanently numbered corresponding to nameplate connection diagram.
2) Shall have solderless lug terminals with at least 2 holes.

q. Two copper grounding pads shall be furnished and located on each side of the motor frame diagonally apart for medium voltage motors. Low voltage motors shall have grounding lug in the conduit box. All terminations shall be provided for the installation.

r. Motor lead splicing: Terminate motor leads using Raychem MCK Series motor connection kits.

s. Space Heaters: When motor is for outdoor service, 120 VAC space heaters shall be included with leads wired out to conduit/terminal box.

11. Thermal Protection:

a. Provide thermal protection related to hp as shown in following table:

		Thermal Device		
Motor Application/Type		Switch	Thermistor	RTDs
Constant Speed	Normal	--	50 ≤ hp ≤ 200	hp > 200
	Explosion Proof	hp ≤ 40		
Adjustable Speed	All	hp ≤ 25	25 > hp ≤ 200	hp > 200

b. Thermal Switch:
   1) Provide normally closed, sealed, thermostat type switch in each phase winding.
   2) The 3 switches shall be wired in series with the leads brought out to the motor terminal box.

c. Thermistor:
   1) Provide a positive temperature coefficient thermistor and a solid state relay.
   2) Completely sealed thermistor shall be installed in the end turns of the stator winding 1 per phase.
   3) Solid state relay shall be mounted in NEMA enclosure on or near the motor enclosure or in a control panel. Mount as shown on the Drawings.
   4) A dry contact shall be provided to shut down the motor in case of high temperature.

d. Resistance Temperature Detectors (RTDs): Provide 6 temperature detectors in the stator winding slots. The location of detectors shall conform to MG1-20.63.
   Each detector shall be 3-wire RTD, Platinum type, with a resistance of 100 ohms at 25°C and equipped with 3 leads. All detectors shall be wired to a terminal strip in an auxiliary terminal box.

e. Motor over temperature protection for motors powered by adjustable frequency drives shall meet the requirements of NEC paragraph 430.126.

2.3 FABRICATION

A. All motors shall be completely factory assembled prior to shipment.

2.4 FINISHES

A. All metal surfaces shall be chemically cleaned and treated to provide a bond between the primer paint and the metal surfaces to prevent the entrance of moisture and the formation of rust under the paint film.

B. All interior and exterior surfaces shall have a base coat and finish coat of corrosion-resistant epoxy paint.

2.5 SOURCE QUALITY CONTROL

A. Factory testing meeting the requirements of "Routine Tests" of the NEMA MG1 publication and the driven equipment Specification Section shall be provided.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motors shall be installed in compliance with the Specification Section for the driven equipment.

B. Motors which are not pre-assembled to driven equipment shall be installed in conformance with motor manufacturer's instructions and driven equipment manufacturer's instructions.

C. Alignment tolerances shall be within the more stringent of the motor manufacturer's requirements or the driven equipment manufacturer's requirements.

D. All motors shall be installed with orientation such that nameplates are in full view.

E. Damaged or non-legible nameplates shall be replaced.

F. Motor overload heater selection shall be based on motor nameplate data (Full Load Amp and Service Factor).

G. Any and all shaft shipping braces shall be removed after the motor is placed in its final location.

H. The motor shall be mounted in accordance with the manufacturer's instructions. Special care shall be taken to ensure that the motor shaft is level.

I. The CONTRACTOR shall install the motor coupling in accordance with the coupling manufacturer's instruction. Under no circumstances shall the motor shaft be modified to accommodate the coupling.

J. The motor shall be aligned axially with driven equipment. This alignment shall be performed and tolerance shall be maintained in accordance with the manufacturer's instruction.

3.2 FIELD QUALITY CONTROL

A. Inspection:
   1. Motors shall be checked for correct phase sequencing and correct rotation in accordance with driven equipment manufacturer's startup procedures before energizing.
      a. Motors up to 100 hp: Bumping motors will not be permitted. CONTRACTOR shall use a battery- operated rotation testing instrument on motors to determine correct wiring sequence before power cables are connected.
      b. Motors above 100 hp: Disconnect motor from driven equipment and "Bump" motor to determine rotation. All permanent overload protective devices must be in place before connecting motor.
   2. Motors shall be checked for damage, moisture, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification, and cleanliness before energizing.

B. Field Tests:
   1. Field tests shall be performed on motors 50 hp and larger.
   2. Insulation Resistance Test: An insulation resistance test shall be successfully completed immediately prior to energizing or beginning the dielectric test. Any machine not passing this test shall be dried and retested. All retesting shall be performed at Contractor’s expense.
      a. Motors less than 200 hp: Tests shall be applied between all phases tied together and ground, and shall include cable back to the starter. The measured insulation resistance at the motor temperature shall be corrected to 20C by multiplying the measured value by the correction factor corresponding to the motor temperature.

R_c = K_m x R_m, where

R_c = Corrected resistance (in megohms at 20°C).

R_m = Measured insulation resistance (in megohms) at temperature t.

K_m = Temperature correction factor for motors at temperature t.

Temp. °C	Temp. °F	Corr. Factor K_m
0	32	0.4
5	41	0.5
10	50	0.6
15	60	0.8
20	68	1.0
25	77	1.3
30	86	1.6
35	95	2.0
40	104	2.5

1) Corrected field test values must meet or exceed the manufacturer's minimum recommended values. If not known, minimum corrected resistance readings shall be as follows:

Equipment	Test Voltage	Minimum Corrected Reading-megohms
480 V 3-phase Induction Motor	1000	20

2) Tests must be held for one minute or until the reading maintains a constant value for 15 seconds.

b. Motors 200 hp and larger shall be given a polarization index test, 10 minutes divided by 1 minute of megohmmeter readings. This test method does not require temperature correction. The recommended minimum value shall be a 1.5 polarization index.

c. Motors 1000 hp and larger shall be field tested per the manufacturer's representative's direction.

d. All test readings and ambient temperature at the time of test shall be recorded, shall be signed by the tester and submitted within 10 days.

3. Final Acceptance: Final acceptance of rotating equipment cannot be made until the equipment is energized during test to ascertain that all design functions are satisfactorily performed. Testing shall include all remote control operation as well as local operation of all motor starters and actuation of all alarm and indication devices according to design specifications. All control circuits, automatic operations and interlocks must be tested by the Contractor for correct and positive operations.

C. Manufacturer’s Field Services:
   1. Motors 100hp and larger: Provide the services of a qualified factory-trained manufacturer’s representative for 8 hours to assist the Contractor in installation and startup of the equipment. The manufacturer’s representative shall provide technical direction and assistance to the Contractor in the general assembly of the motor, connections and adjustments, and testing of the motor and components contained therein.
   2. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer’s service representative:
      a. Verification of proper mounting and alignment
      b. Final inspection of the lubrication system
      c. Final inspection of the cooling system
      d. Supervision of the meggar test
      e. Supervision of the final coupled test
   3. Submit the manufacturer’s field startup report.

D. Manufacturer’s Certification:
   1. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
   2. Submit the manufacturer's representative's certification.

3.3 ADJUSTING

A. The Contractor shall fill any oil reservoir with the manufacturer’s specified oil.

B. If the manufacturer requires that the anti-friction bearings receive an initial change of grease, the Contractor shall perform such work.

C. Motors that are supplied with provisions for flood lubrication: The Contractor shall assure that the proper supply pressure is present.

D. The motor shaft shall be turned by hand to ensure there is free rotation.

E. The area around the external fan inlet shall be checked for loose debris that could be drawn into the fan during operation.

F. All external, factory-made, bolted joints should be checked for tightness.

3.4 CLEANING

A. Any slushing compound on the shaft or other parts shall be removed using a petroleum-type solvent.

END OF SECTION 26 2000

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SECTION 26 2200

TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install transformers in accordance with the plans and as specified herein.

B. Work of this Section includes, but is not limited to:
   1. Dry-type distribution transformers.
   2. Individual K-rated dry type transformers.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work to furnish and install transformers in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Electrical Component Standard: Components and installation shall comply with National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."
   2. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Compliance: Comply with applicable requirements of ANSI/IEEE Standards including C2, "National Electrical Safety Code," and C57.12.80, "Terminology for Power and Distribution Transformers."
   3. Nationally Recognized Testing Laboratory Compliance (NRTL): Items provided under this section shall be NRTL listed and labeled. The term "NRTL" shall be as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.

B. Qualifications
   1. Manufacturer Qualifications: Member firm of National Electrical Manufacturers Association (NEMA) who is regularly engaged in manufacturing components that comply with the requirements of these specifications and that have been used on at least five projects of similar size and scope as this project.
   2. Testing: Manufacturer's standard shop test shall be performed in accordance with the latest version of ANSI and NEMA standards and shall include as a minimum the following. Provide certified factory test reports.
      a. Ratio tests at the rated voltage connection and at all tap connections.
      b. Polarity and phase relation tests on the rated voltage connection.
      c. Applied potential tests.
      d. Induced potential tests.
      e. No-load and excitation current at rated voltage on the rated voltage connection.
   3. Field Testing Organization Qualifications: To qualify for acceptance, an independent testing organization must demonstrate, based on evaluation of organization submitted

criteria conforming to American Society for Testing and Materials (ASTM) E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Wiring diagrams from manufacturer differentiating between manufacturer installed and field installed wiring.

C. Product certificates, signed by manufacturer of transformers certifying that their products comply with the specified requirements.

PART 2 - PRODUCTS

2.1 TRANSFORMERS, GENERAL

A. Transformers: Factory assembled and tested, air cooled units of types specified, having characteristics and ratings as indicated. Units shall be designed for 60 Hertz (Hz) service.
   1. Cores: Grain oriented, non-aging silicon steel.
   2. Coils: Continuous copper windings without splices except for taps.
   3. Internal Coil Connections: Brazed or pressure type.

B. General Purpose, Dry Type Transformers
   1. Comply with NEMA Standard ST 20 "Dry Type Transformers for General Applications."
   2. Windings: Two winding type. Three phase transformers shall use one coil per phase in primary and secondary.
   3. Enclosures: Indoor ventilated, unless noted otherwise.
   4. Insulation Class: 185 deg C or 220 deg C class for transformers 15 kilovolt amperes (kVA) or smaller; 220 deg C class for transformers larger than 15 kVA.
   5. Insulation Temperature Rise: 115 deg C maximum rise above 40 deg C.
   6. Taps: For transformers 3 kVA and larger, full capacity taps in high voltage winding as follows:
      a. 15 - 500 kVA: Six 2.5% taps, two above and four below rated high voltage.
   7. Accessories: The following accessory items are required where indicated:
      a. Wall Mounting Brackets. Manufacturer’s standard brackets for transformers sized up to 75 kVA where wall mounting is indicated.
   8. Transformer sound levels shall not exceed ANSI standards.
   9. Transformers installed in an area which has sprinklers shall have a weathershield.

C. K-Rated Transformers: K-rated transformers shall be as specified above, and in addition shall have the following features:
   1. K-rating of not less than 13.
   2. Secondary neutral terminal shall be sized for 200% of the secondary phase current.
   3. Full width electrostatic shielding between primary and secondary winding and ground to the transformer core.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:
   1. Transformers
      a. Eaton Corporation.
      b. General Electric Company.
      c. Square D Company.
      d. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arrange equipment with a minimum clearance of 6 inches from any wall, to provide adequate spacing for cooling air circulation.

B. Identify transformers in accordance with Division 26 Section “Electrical Identification”.

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL Standards 486A and 486B.

D. Install units on vibration mounts as shown; comply with manufacturer's indicated installation method, if any.

E. Provide a housekeeping pad under all floor mounted transformers.

F. Install bracket for wall mounted transformers using anchors and fasteners suitable for the weight of the transformer and all accessories.

3.2 GROUNDING

A. Ground transformers and tighten connections to comply with tightening torques specified in UL Standard 486A.

B. Transformer secondary neutral shall be grounded to building structural steel in conformance with the NEC.

3.3 ADJUSTING AND CLEANING

A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

3.4 PROTECTION

A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 26 2200

SECTION 26 2413

SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of the specification sections, apply to this Section.

B. Related Sections include the following:
   1. Division 26 Section “Surge Protective Devices”.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install switchboards in accordance with the Plans and as specified herein.

B. This section includes low voltage power service and distribution switchboards and associated auxiliary equipment rated 600 volts or less.

1.3 CODES AND STANDARDS

A. General: Perform all work to furnish and install switchboards in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Listing and Labeling: Provide switchboard assemblies that are listed and labeled.
      a. The terms "listed" and "labeled" as defined in the National Electrical Code (NEC), Article 100.
   2. Electrical Component Standard: Components and installation shall comply with National Fire Protection Association (NFPA) 70, "NEC."
   3. National Electrical Manufacturers Association (NEMA) Standard: Comply with NEMA Standard PB2, "Dead front Distribution Switchboards”.
   4. Underwriters' Laboratories, Inc. (UL) Standard: Comply with UL 891, "Dead front Switchboards."

1.4 QUALITY ASSURANCE

A. Manufacturer's Field Representative
   1. The Manufacturer of the Work of this Section shall provide a qualified field representative at the site.
   2. Such Manufacturer's field representative shall instruct the Contractor's personnel in the proper handling, installation, start-up, operation, and maintenance of the equipment.
   3. Such Manufacturer's field representative shall instruct the Owner's personnel in the proper start-up, operation, and maintenance of the equipment. The instruction period shall be a minimum of 8 hours.

B. Manufacturer's Qualifications: The Manufacturer of Work of this Section shall have 5 years minimum proven experience in such work and shall have satisfactorily completed 3 jobs of similar size and type within the last 5 years.

C. Testing
   1. Manufacturer's standard shop test shall be performed.
   2. Perform all tests indicated under PART 3 - EXECUTION.

1.5 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 specification sections.

B. Reference Submittals
   1. Test procedures and test reports.
   2. Operating and maintenance instructions.
   3. Spare parts list.
   4. Agenda of training class.

C. Product Data
   1. Submit for each switchboard component.
   2. Including, but not limited to, shipping, storage, and installation instructions.
   3. Product features brochure.
   4. Time-current characteristic curves for overcurrent protective devices.

D. Shop Drawings
   1. Single line drawings.
   2. Dimensional plans and elevations showing major components and features.
   3. Component details.
   4. Accessories.
   5. Materials list.
   6. Nameplate legends.
   7. Size and number of bus bars and current rating for each bus including mains and branches of phase, neutral, and ground buses.
   8. Short-circuit current ratings of switchboards and components.
   9. Ratings of individual protective devices.
   10. Metering provisions.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store so condensation will not occur on or in switchboards. Provide temporary heaters as required to assure avoiding condensation.

C. Handle switchboards in accordance with NEMA Standard PB2.1, "General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards." Use factory installed lifting provisions.

1.7 EXTRA MATERIALS

A. Furnish extra materials matching products installed as described below, packaged with protective cover when moved for storage, and identified with labels clearly describing contents. Deliver to the Owner.
   1. Touch Up Paint: Three (3) half pint containers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Description. Front connected, fully bused, front accessible, panel mounted main and branches, and sections rear aligned.

B. Enclosure and Accessories
   1. Enclosure Finish. Manufacturer's standard gray finish over a rust inhibiting primer on phosphatizing treated metal surface. Provide painted surfaces that conform to IEEE C37.20.1, "Standard for Metal Enclosed Low Voltage Power Circuit Breaker Switchgear," paragraph 5.2.8.
   2. Hinged Front Panels: Provide to allow access to breaker, metering, accessory, and blank compartments.
   3. Buses and Connections: Three phase, four wire except as otherwise indicated. Features as follows:
      a. Phase and Neutral Bus Material: Hard drawn silver-plated copper of 98 percent conductivity with feeder circuit breaker line connections.
      b. Bus shall be copper. Use copper for feeder circuit breaker line connections.
      c. Ground Bus: Full length, 1/4 inch by 2 inch minimum size, hard drawn silver plated copper of 98 percent conductivity, and equipped with pressure connector terminations for feeder and branch circuit ground conductors.
      d. Supports and Bracing for Buses: 65,000 A RMS symmetrical fault current at rated voltage.
      e. Contact Surfaces of Buses: Silver-plated.
      f. Main Phase Buses, Neutral Bus, and Equipment Ground Bus: Uniform capacity (non-tapered) the entire length of the switchboard main and distribution sections. Provide for future extensions from either end by means of bolt holes or other approved method and connecting links.
      g. Neutral Buses: One hundred percent ampacity of the phase buses, unless noted otherwise, equipped with pressure connector terminations for outgoing circuit neutral cables.

C. Overcurrent Protective Devices
   1. Comply with requirements of Division 26, Section "Overcurrent Protective Devices (OCPDs)", for types of OCPDs indicated. Provide indicated features, ratings, characteristics, and settings.
   2. Future Devices: Where provision for future overcurrent protective devices or space is indicated, equip compartments with mounting brackets, supports, bus connections, and necessary appurtenances, designed for the OCPD types and ampere ratings indicated for future installation of devices.

D. Other Circuit Control and Protective Devices
   1. Provide surge arresters.
      a. Comply with IEEE C62.11, "Standards for Metal Oxide Surge Arresters for AC Power Circuits," or IEEE C62.1 "Surge Arresters for Alternating Current Power Circuits."
      b. Coordinate impulse spark-over voltage with system circuit voltage, and provide factory mounting and connection.
   2. Surge Protective Devices (SPD). Provide SPDs as specified in Division 26, Section "Surge Protective Devices".

E. Instrumentation
   1. Instrument Transformers: As specified in Division 26, Section "Electrical Power Monitoring and Control."
   2. Multifunction Digital Metering:
      a. As specified in Division 26, Section "Electrical Power Monitoring and Control."
      b. Mount display and control unit flush or semi-flush in compartment door.

F. Ratings: Provide nominal system voltage, continuous main bus amperage, and short circuit current ratings as indicated.
   1. Nominal System Voltage: 480Y/277 volts, 60 hertz (Hz).
   2. Main Bus Continuous: As shown on plans.
   3. Short Time and Short Circuit Current Ratings: 65,000 AIC.

G. Accessory Components and Features
   1. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

H. Identification
   1. General: Refer to Division 26, Section "Electrical Identification". Identify units, devices, controls, and wiring with factory applied labels and signs.
   2. Compartment Nameplates: Engraved laminated plastic for each compartment, mounted with corrosion resistant screws.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Eaton Corporation.
   2. General Electric Company.
   3. Square D Company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards and accessory items in accordance with manufacturer's written installation instructions.

B. Anchor each switchboard assembly to two 4 inch minimum channel iron sills arranged in accordance with manufacturer's recommendations. Attach by bolting. Level and grout sills flush with switchboard mounting surface.

C. Housekeeping Pads: Provide 4-inch thick housekeeping pads for all switchboards.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

E. Operating Instructions: Frame and mount printed, basic operating instructions for switchboards, including control and key interlocking sequences, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on the front of the switchboards.

F. Tighten switchboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer's published torque tightening values. Where manufacturer's torque values are not stated, use those specified in UL Standards 486A and 486B.

3.2 IDENTIFICATION

A. Identify field installed wiring and components and provide warning signs as specified in Division 26, Section “Electrical Identification.”

B. Provide nameplates on each compartment.

3.3 GROUNDING

A. Tighten connections to comply with tightening torques specified in UL Standards 486A and 486B.

B. Ground equipment to main electrical ground bus indicated. Provide maximum 5 ohm ground resistance at switchboard location.

3.4 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspections: Include the following inspections and related work:
   1. Inspect for defects and physical damage, testing laboratory, labels, and nameplate compliance with up to date circuit connections.
   2. Verify that current transformers meet specified requirements.
   3. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
   4. Check switchboard anchorage, area clearances, and alignment and fit of components.
   5. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   6. Clean switchboard interior and exterior using manufacturer's approved methods and materials.
   7. Perform visual and mechanical inspection and related work for OCPDs as specified in Division 26, Section “Overcurrent Protective Devices”.

3.5 CLEANING

A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.6 PROTECTION

A. Apply temporary heat in accordance with manufacturer's recommendation within each section of switchboards throughout periods during which the switchboard is not in a space that is continuously under normal control of temperature and humidity.

3.7 DEMONSTRATION

A. Arrange and pay for the services of factory authorized service representatives to demonstrate switchboards and train Owner's maintenance personnel.

B. Conduct a minimum of one half day of training in operation and maintenance as specified under "Instructions to Owner Employees" in Division 01. Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least 7 days' advance notification.

END OF SECTION 26 2413

SECTION 26 2416

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall provide the labor, tools, equipment, and materials necessary to install panelboards and enclosures in accordance with the plans and as specified herein.

B. Types of panelboards and enclosures required for the project include the following:
   1. Panelboards.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with panelboards in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and National Electrical Code (NEC) Article 384 as applicable to installation, and construction of electrical panelboards and enclosures.
   2. Underwriters' Laboratories, Inc. (UL) Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL Numbers 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories and enclosures. Provide panelboard units which are UL-listed and -labeled.
   3. Special Use Markings: Provide panelboards, constructed for special use, with appropriate UL markings which indicate that they are suitable for special type of use/application.
   4. National Electrical Manufacturers Association (NEMA) Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

1.4 SUBMITTALS

A. Submit manufacturer's data on panelboards, components, and enclosures.

B. Submit shop drawings from manufacturers of panelboards including dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:
   1. Enclosure type with details for types other than NEMA Type 1.
   2. Bus configuration and current ratings.
   3. Short circuit current rating of panelboard.

4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

C. Reference Submittals
1. Manufacturer's descriptive literature.
2. Operating and maintenance instructions.
3. Spare parts list.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver panelboards and components properly packaged in factory-fabricated-type containers.

B. Handle panelboards and components carefully to avoid breakages, impacts, denting, and scoring finished. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

C. Store panelboards and components in original packaging and in a clean, dry space; protect from weather and construction traffic.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of panelboards and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General
1. Comply with manufacturer's standard materials, design and construction in accordance with published product information.
2. All panelboards shall be from the same manufacturer.

B. Panelboards
1. Dead-front safety type.
2. Fully rated (series rating is not acceptable).
3. Minimum RMS symmetrical short circuit current rating.
a. 10,000 Amperes at 120/240V.
b. 18,000 amperes at 277V.
c. 35,000 amperes at 480V.
4. Voltage rating, phase as shown.
5. Anti-burn solder-less pressure type lugs approved for use with copper conductors.
6. Copper bus bars, full-sized copper neutral bar.
7. Two hundred percent rated solid neutral bus bar where shown.
8. Factory installed copper grounding bars.
9. Provide suitable lugs on neutral bus for each outgoing feeder required.

C. Enclosure
1. Galvanized sheet steel cabinet-type enclosure.
2. NEMA 1 or 12 rated as shown.
3. Fabricated by same manufacturer as panelboard.

4. Multiple knockouts and wiring gutters.
5. Cover with adjustable trim clamps, and doors with flush locks and keys
6. All panelboard enclosures keyed alike; 2 keys with each lock.
7. Concealed piano door hinges.
8. Interior circuit directory frame and card with clear plastic covering.
9. Baked gray enamel finish over a rust inhibitor coating.

D. Molded Case Circuit Breakers
1. As specified is Division 26, Section “Overcurrent Protective Devices.”
2. Quantities, ratings, types and arrangements as shown on the schedules.
3. Main breakers where provided mounted vertically and above the branch circuit breakers.
4. Provide circuit breakers as specified in Division 26, Section “Overcurrent Protective Devices”. Panelboards shall have main circuit breaker or main lugs, and branch circuit breakers as shown on the schedules.
5. Provide circuit breaker handle locks for all circuit breakers that supply exit and emergency lighting, fire alarm equipment, and where indicated on plan or schedule.

E. Accessories
1. Ground fault protection units where shown.
2. Surge Protective Devices in all panelboards as specified in Division 26, Section “Surge Protective Devices”.
3. Breaker Handle Locking Clips
   a. All branch breakers that supply exit and emergency lighting
   b. All branch breakers that supply fire alarm and security equipment.
   c. Where shown.

F. Provide equipment identification nameplates complying with Division 26, Section “Electrical Identification”.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide panelboard products of one of the following (for each type and rating of panelboard and enclosure):
1. Eaton Corporation.
2. General Electric Company.
3. Square D Company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and National Electrical Contractors Association's (NECA) "Standards of Installation," and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

C. Fasten surface-mounted enclosures firmly to walls with 1/4-inch space between wall and panelboard, ensuring that they are permanently and mechanically anchored.

D. Provide properly wired electrical connections for panelboards within enclosures.

E. Fill out the circuit directory card for each panelboard.
   1. Type the directory, do not hand write.
   2. Do not fill in the directory until after balancing the loads.

3.2 EXAMINATION

A. Examine areas and conditions under which panelboards and enclosures are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.3 GROUNDING

A. Provide equipment grounding connections for panelboard enclosures as indicated. Tighten connections to comply with tightening torques specified in UL 486A to ensure permanent and effective grounds. All panelboards shall be properly grounded. Special requirements shall be as indicated on plans.

3.4 FIELD QUALITY CONTROL

A. Prior to energizing electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

B. Prior to energizing of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

C. Prior to energizing, check panelboards for electrical continuity of circuits, and for short circuits.

D. Measure steady state load currents at each panelboard feeder and rearrange circuits in the panelboard to balance the phase loads within 10% of each other. Maintain proper phasing for multi-wire branch circuits.

3.5 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch up scratched or marred surfaces to match original finishes.

3.6 DEMONSTRATION

A. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 26 2416

SECTION 26 2419

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install MCCs in accordance with the plans and as specified herein.
   1. This section includes MCCs for use on alternating current (AC) circuits rated 600 volts (V) or less. Extent of MCC work is indicated by drawings and schedules.
   2. Types of MCC components specified in this section include the following:
      a. MCC supporting structures.
      b. Bus systems.
      c. Unit compartments.
      d. Motor controller units.
      e. Feeder units.
      f. Overload protection.
      g. Overcurrent protection.
      h. Control components.

B. Related Documents
   1. Drawings and general provisions of the Contract.
   2. General and Supplementary Conditions.
   3. All Division 1 specification sections.
   4. Division 26 Section “Electrical Identification”.
   5. Division 26 Section “Control Devices”.
   6. Division 26 Section “Overcurrent Protective Devices”.
   7. Division 26 Section “Motor Controllers”.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work to furnish and install in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Unless otherwise stated, references are to the latest edition of the standard.
      a. Underwriter's Laboratory (UL)
         1) 845, “Motor Control Centers.”
         2) 486A/486B, “Wire Connectors and Soldering Lugs for Use With Copper Conductors.”
      b. National Electrical Manufacturers Association (NEMA)
         1) 250, “Enclosures for Electrical Equipment (1000 Volts Maximum).”
         2) ICS 2, “Standards for Industrial Control Devices, Controllers and Assemblies.”

3) ICS 2.3, “Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers.”
4) ICS 18, “Industrial Control and Systems: Motor Control Systems.”

c. National Fire Protection Association (NFPA)
1) NFPA70 – The National Electrical Code.

B. Manufacturer's Field Representative
1. The Manufacturer of the Work of this Section shall provide a qualified field representative at the site.
2. Such Manufacturer's field representative shall instruct the Contractor's personnel in the proper handling, installation, start-up, operation, and maintenance of the equipment.
3. Such Manufacturer's field representative shall instruct the Owner's personnel in the proper start-up, operation, and maintenance of the equipment.

C. Testing: Manufacturer's standard factory tests shall be performed.

1.4 DEFINITIONS

A. Abbreviations
1. AHJ. Authority having jurisdiction.
2. FVNR. Full voltage non-reversing.
3. MCC. Motor control center.
4. NRTL. Nationally recognized testing laboratory.
5. SCADA. Supervisory control and data acquisition.
6. SPD. Surge protective device.

B. Seismic Withstand: When subjected to the specified seismic forces, seismic withstand means:
1. The unit will remain in place.
2. No parts will separate from the unit.
3. The unit will be fully operational after the seismic event.

1.5 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and material specifications as required.

B. Reference Submittals
1. Installer's certification.
2. Manufacturer's certification.
3. Manufacturer's descriptive literature.
4. Certified production test reports.
5. Operating and maintenance instructions.

C. Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
1. Product Data: Submit manufacturer's technical product data on MCC. Application data to include, but not limited to, the following:
a. Voltage.
b. Phase.
c. Frequency.
d. Horizontal bus capacity.

e. Vertical bus capacity.
f. Short circuit ratings.
g. Main and branch circuit breakers ratings.
h. Types of motor controllers.
i. Types of wiring (NEMA type wiring).
j. Enclosures.
k. Sections.
l. Motor size and overload heaters.

2. Shop Drawings: Submit layout drawings of MCCs showing accurate scaled basic equipment sections including, but not limited to, motor controllers, device panels, and circuit breakers. Show spatial relationships of MCC components to proximate electrical equipment. Submit unit wiring diagrams and elementary control diagrams. Clearly differentiate on wiring diagrams those conductors which are factory installed and those which are field installed.
   a. Front view elevation.
   b. Floor plan.
   c. Single line.
   d. Unit wiring diagrams depicting remote devices.
   e. Nameplate schedule.
   f. Starter and component schedule.
   g. Conduit entry/exit locations.
3. Maintenance Data: Submit maintenance data and parts list for each MCC; including "troubleshooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual.
4. Overload Relay Heater List: Submit for approval overload relay heater sizes for each new motor starter furnished or existing motor starter modified. Motor overload relay heater size shall be based on actual motor nameplate data (shop drawing is not acceptable) and power factor correction size; where applicable. Submit for approval motor overload relay heater sizing criteria, manufacturer, support calculations, motor nameplate data, capacitor nameplate data, and manufacturer tables used.
5. Submit agenda of training class.

D. A Renewal Parts List shall be submitted by the Manufacturer and Contractor showing the important maintenance items which will need to be available for proper maintenance and to provide normal equipment life.

E. Contract Closeout Submittals
1. Project record documents.
2. Operation and maintenance (O&M) data
   a. Submit O&M manual prior to delivery of the products.
   b. Include instructions on start-up, operation, and maintenance.
   c. Include a complete parts list and a recommended spare parts list.

1.6 QUALITY ASSURANCE

A. Regulatory requirements: Perform all work in compliance with the following:
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

B. Testing Agency Qualifications
1. Member of NETA.

2. Acceptable to authorities having jurisdiction.
3. Field Supervisor currently certified by the NETA.

C. Product Selection for Restricted Space
1. Drawings indicate maximum dimensions for MCCs.
2. Comply with indicated maximum dimensions.

1.7 DELIVERY, HANDLING, AND STORAGE

A. General: Comply with Division 1 Product Requirements Sections.

B. Packing and shipping
1. Package equipment as required to prevent damage during shipment.
2. Cover each shipping section with plastic wrapping for moisture protection.
3. Mount on pallets or skids to facilitate handling.
4. Inspect for damage and completeness upon receipt
5. Limit shipping splits to a maximum of 5’-0”.

C. Handling.
1. Conform to the requirements of NEMA ICS 2.3.
2. Use factory installed lifting provisions.

D. Storage and protection
1. Store the products until they can be installed.
2. Meet the storage requirements of the manufacturer.
3. Store so condensation will not occur on or in MCCs. Provide temporary heaters as required to prevent condensation. If the motor control center cannot be placed into service reasonably soon after its receipt, it should be stored in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperatures are from 0°C (32°F) to 40°C (104°F).

1.8 SEQUENCING AND SCHEDULING

A. Sequence and coordinate equipment installations for efficient flow of the work.

B. Place equipment in service as required to maintain the facility in operation and to allow further construction to proceed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Motor Control Centers
1. General
a. Provide MCCs and ancillary components of sizes, rating classes, types, and characteristics, indicated; which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for complete installation and as specified herein. See the plans for required components.
b. Conduit entrance shall be via a grounding, threaded fitting.

2. Provide MCCs consisting of one or more vertical sections, each with groupings of unit compartments containing motor controllers, feeder, and auxiliary devices as indicated.
3. Design MCC for connection to available faults of not less than 42,000 RMS symmetrical amperes or as shown on plans. Provide MCC with NEMA Class 2, Type B wiring. All wiring shall be identified by permanent plastic heat shrink label at each termination.
4. Provide factory assembled, deadfront, MCC standard supporting structures of Classes and Types indicated; with enclosed vertical sections, as indicated, fastened together to form rigid free standing assembly.
    a. Construct each section 90 inches high with minimum 6 inch horizontal wireways at top and bottom, 20 inches wide, and a minimum of 20 inch section depth except back to back structures shall be 25 inches in depth.
    b. Top horizontal wireway shall be isolated from horizontal bus.
    c. Provide NEMA Type 1 gasketed enclosure.
    d. Construct units with vertical wireway in each vertical structure on right side of unit, accessible through hinged doors, and with supports at proper intervals within for fastening wires/cables. Form supporting members of not less than 13 gauge hot rolled steel.
    e. Construct structure doors with removable pin hinges and secure with quarter turn indicating type fasteners.
    f. Provide removable lifting angle full length of MCC. Design lifting angle to support entire weight of MCC section. Design bottom channels to be removable, provide holes for bolting MCC units to floor.
    g. Provide shipping splits in MCC lineup to allow for shipment of maximum 60 inch long units. Design MCCs so matching vertical sections of same current rating and manufacturer can be added later at either end of lineup without use of transition sections. Provide removable end and top plates to close off openings.
5. Construct bus bars of tin plated copper, braced to withstand faults of 42,000 RMS symmetrical amperes minimum or as indicated on plans. Provide main horizontal bus with rating of 600 amperes, and vertical bus rating of 300 amperes unless otherwise noted. Construct vertical bus bar barriers with automatic shutters to cover bus stab openings when units are removed.
    a. Provide tin plated copper ground bus running full width of MCC at bottom of lineup. Drill ground bus and furnish lugs as indicated
6. Provide draw out type unit compartments with doors, unit support pans, saddles, and disconnect operators. Enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments and with a minimum withstandability equal to that of the bus bracing. Provide draw out units with a de-energized position where the unit is still supported by the structure, but no electrical connection is made. Provide a method of locking the unit in the de-energized position. Design plug in units of the same type and size to be interchangeable with each other. Provide plug on connections for each electrical power phase. Design the contact fingers to be floating and self-aligning. Tin plate the contacts for low resistance connections. Interiors shall be painted white or off white. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. All control wire to be 14 gauge minimum.
7. Provide external operator handles for controllers, switches, and circuit breakers. Design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with three padlocks.
8. Provide unit doors securely mounted with a minimum of two rugged concealed type hinges which allows doors to swing open minimum of 115 degrees for ease of unit

maintenance and withdrawal. Fasten doors to structure so that they remain in place when unit is withdrawn.

a. Closed door must cover unit space when unit has been temporarily removed. Provide interlock for each unit door with associated disconnect mechanism to prevent door from opening when unit is energized.

9. Circuit Breakers: See Division 26 Section “Overcurrent Protective Devices”. Devices shall have a minimum RMS symmetrical interrupting rating of 42,000 A at 480/277V.
10. Main Circuit Breakers: Provide solid state trip circuit breakers. See plans and/or schedules for size. See Division 26 Section “Overcurrent Protective Devices”. Devices shall have a minimum RMS symmetrical interrupting rating of 42,000 A at 480/277V.
11. Provide combination type motor controller units, types as specified in Division 26 Section “Motor Controllers”, with thermal magnetic circuit breaker or fused switch and ambient compensated, manual reset, inverse time, thermal overload relay. Overload protection shall be provided in each phase conductor. Provide overload heaters sized based upon motor nameplate current. Provide a 120 volt control power transformer for each motor controller unit with two primary fuses and one secondary fuse. The transformer secondary shall be grounded. Provide a minimum of three normally open and one normally closed auxiliary contacts. Units shall be NEMA rated.
12. All control component conductors shall be landed with vinyl insulated locking fork terminals. Elapsed time meters shall be mounted in the unit doors and shall have a 120 volt synchronous motor driving a mechanical register. The register shall indicate up to 99,999.9 hours. Each motor starter NEMA Size 2 or larger shall have a current sensing phase unbalance relay to trip the starter on loss of phase or phase unbalance of 50 percent or more when at 50 percent or more load.
13. Provide equipment/system identification nameplates complying with Division 26 Section “Electrical Identification”, in accordance with Motor Control Schedule on drawings. Tags shall be engraved plastic laminate.
14. Thoroughly clean interior and exterior of supporting structures and unit compartments prior to coating of MCC, including bolted joints, with rust-inhibiting prime coat. Provide two finish coats of manufacturer's standard color baked on enamel finish.
15. Provide Allen-Bradley PowerMonitor 5000 with Ethernet/IP communications for power monitoring where shown on the Drawings.
16. Provide SPDs as shown and as specified in Division 26 Section “Surge Protective Devices”.

B. Extra Materials

1. Furnish six spares of each type and rating of fuse and fusible devices required. Include spares for:
   a. Control power fuses.
   b. Fuses and fusible devices for fused circuit breakers.
   c. Fuses for fusible switches.
2. Spare Indicating Lights: Furnish six of each type required.
3. Touch-Up Paint: Furnish three 1/2 pint containers.

2.2 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

1. Allen-Bradley.
2. Cutler-Hammer.
3. Square D.

4. Or Approved Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
   1. Inspect installed work prior to performing the work of this section.
   2. Verify that the project has progressed to a point where this installation may begin.

B. Discrepancies
   1. Immediately notify the A/E in writing of conditions detrimental to proper completion of the work.
   2. Correct all unsatisfactory conditions before proceeding with installation.
   3. Resolution must be acceptable to the A/E.

3.2 PREPARATION

A. Surface Preparation
   1. Carefully lay out the work in advance.
   2. Perform any cutting, drilling, etc. without damaging the building surfaces or equipment.

B. Rough-in
   1. Refer to equipment submittals for rough-in requirements.
   2. Verify rough-in locations by field measurements.

3.3 INSTALLATION

A. Installation of Motor Control Centers
   1. Install MCCs as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Standard Pub/No. ICS-2, and NEC "Standard of Installation."
   2. Provide and install housekeeping pads for all motor control centers.
   3. Coordinate with other electrical work including wiring/cabling and raceway work, as necessary to interface installation of motor control centers with other work. Install control wiring from master terminal block in top and bottom horizontal wireways to each associated unit compartment terminal blocks.
   4. Install fuses, if any, in motor control center units.
   5. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.
   6. Control wiring shall be as shown on the contract drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.

B. Adjusting and Cleaning
   1. Adjust operating mechanisms for free mechanical movement.
   2. Touch up scratched or marred surfaces to match original finishes.

C. Grounding: Provide equipment grounding connections for MCCs as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

3.4 FIELD QUALITY CONTROL

A. Prior to energization of MCCs, check with insulation resistance tester for proper values of phase-to-phase and phase-to-ground insulation resistances. Log that data, and submit to Engineer.

B. Prior to energization of circuitry, check control center electrical circuits for continuity and for short circuits.

C. Subsequent to wire/cable and raceway hook ups, energize MCC circuitry check each motor for proper phase rotation, and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

D. Install approved overloads after all wiring is checked.

E. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
   1. Perform insulation tests on each phase and verify low resistance ground connection on ground bus.
   2. Torque all bolted connections made in the field and verify all factory bolted connections.
   3. Verify proper application of motor overloads and motor circuit protectors against actual nameplate data.
   4. Prior to energizing MCCs, check electrical circuits for continuity and for short circuits.
   5. After energizing MCCs, check each motor for proper phase rotation.
   6. Repair or replace any defective equipment or wiring then re-test.
   7. The Contractor shall provide three (3) copies of the manufacturer's field startup report before final payment is made.

3.5 FIELD ADJUSTMENTS

A. Follow the manufacturer's instructions and the contract documents concerning any short circuit device settings, heater selection, timing relays, or startup of components.

3.6 CLEANING

A. Touch up scratched or marred surfaces to match original finishes.

3.7 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.

3.8 TRAINING

A. The Contractor shall provide a training session for one normal workday (8 hours) at the jobsite or other office location chosen by the Owner.

B. The training session shall be conducted by a manufacturer's qualified representative.

C. The training program shall consist of the following:
   1. Review of the MCC one-line drawings and schedules.
   2. Review of the factory record shop drawings and placement of the various cells.
   3. Review of each type of starter cell, components within, control and power wiring.
   4. Review contactor coil replacement, and contact replacement procedures.
   5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
   6. Provide three ring binders to participants complete with copies of drawings and other course material covered.

END OF SECTION 26 2419

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SECTION 26 2716

CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to work of this Section.

B. This section is a Division 26 section, and is a part of each Division 26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install electrical boxes and fittings in accordance with the plans and as specified herein.

B. Types of electrical boxes and fittings specified in this section include the following:
1. Outlet boxes.
2. Junction boxes.
3. Pull boxes.
4. Floor boxes.
5. Bushings.
6. Locknuts.
7. Knockout closures.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. National Electrical Code (NEC) Compliance. Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
2. Underwriters' Laboratories (UL) Compliance. Comply with applicable requirements of UL 50, UL 514 Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes, fittings and enclosures which are UL listed and labeled.
3. National Electrical Manufacturer's Association (NEMA) Compliance. Comply with applicable requirements of NEMA Standard Publication Nos. OS1, OS2, and 250 pertaining to outlet and device boxes, covers, and box supports.
4. Federal Specification (FS) Compliance. Comply with applicable requirements of FS W-C-586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies and Entrance Caps."

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Shop Drawings for Electrical Boxes and Fittings: For shop-fabricated junction and pullboxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.

1.5 DEFINITIONS

A. Finished locations. The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

B. Interior locations. The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

C. Wet locations. The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

D. Corrosive locations. The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

E. Hazardous (classified) locations. The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Store cabinets, boxes and fittings in clean, dry space; protect products from weather, damaging fumes, construction debris and traffic.

PART 2 - PRODUCTS

2.1 ELECTRICAL BOXES AND FITTINGS

A. Electrical cabinets, boxes and fittings of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations. Provide corrosion-resistant box knockout closures to suit respective installation requirements and applications.

2.2 METALLIC OUTLET, DEVICE AND WIRING BOXES

A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical" and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application.

B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes, and

accessories suitable for each location, including mounting brackets and straps, cable clamps, exterior rings, and fixture studs.

C. Cast Aluminum Boxes: Copper-free aluminum threaded raceway entries and features and accessories suitable for each location including mounting ears, threaded screw holes for devices, and closure plugs.

2.3 NON-METALLIC OUTLET, DEVICE, AND WIRING BOXES

A. General: Conform to NEMA OS 2, "Non-Metallic Outlet Boxes, Device Boxes, Covers, and Box Supports," and UL 514C, "Non-Metallic Outlet Boxes, Flush Device Boxes, and Covers." Boxes shall be molded PVC units of type, shape, size, and depth to suit location and application.

B. Non-Metallic Boxes: Ultraviolet stabilized, non-conductive, high-impact-resistant boxes with integrally molded raceway entrance hubs and removable mounting flanges. Boxes shall be equipped with threaded screw holes for device and cover plate mounting. Each box shall have molded cover of matching polyvinyl chloride (PVC) material suitable for the application.

2.4 PULL AND JUNCTION BOXES

A. General: Comply with UL 50, "Electrical Cabinets and Boxes," for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted-on covers of same material as box and shall be of size and shape to suit application. All boxes 6-inch x 6-inch or larger shall have hinged doors. All boxes used for distribution of emergency power shall be painted red.

B. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanize after fabrication. Cover shall be gasketed.

C. Stainless Steel Boxes: Fabricate of stainless steel conforming to Type 302 of American Society for Testing and Materials (ASTM) A 167, "Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip." Where necessary to provide a rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.

D. Cast Aluminum Boxes: Molded of copper-free aluminum, with gasketed cover and integral threaded conduit entrances.

E. Cast Nonmetallic Boxes: Ultraviolet stabilized, non-conductive, high-impact-resistant PVC boxes with gasketed cover and integral mounting flanges.

2.5 STEEL ENCLOSURES WITH HINGED DOORS

A. General: Comply with UL 50, "Cabinets and Enclosures," and NEMA ICS6 "Enclosures for Industrial Control and Systems."

B. Construction: Sheet steel, 16-gauge, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface-mounting.

C. Doors: Hinged directly to cabinet and removable with approximately 3/4-inch flange around all edges, shaped to cover edge of box. Provide handle-operated, key-locking latch. Individual door width shall be no greater than 24 inches. Provide multiple doors where required.

D. Mounting Panel: Provide painted removable internal mounting panel for component installation.

E. Enclosure: NEMA 12, unless noted otherwise. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips.

2.6 CAST METALLIC ENCLOSURES WITH HINGED DOORS

A. General: Copper-free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for the classification of hazard involved.

2.7 MOLDED NONMETALLIC ENCLOSURES WITH HINGED DOOR

A. General: Molded, glass-fiber-reinforced high-impact-strength polyester with bolt or screw-secured doors and solid neoprene gaskets.

2.8 CORROSION INHIBITORS

A. General: All enclosures containing equipment, terminals, or splices shall have a vapor phase corrosion inhibitor. Provide two spares for each one installed.

2.9 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Adalet-PLM Div.; Scott Fetzer Co.
2. American Electric.
3. Arrow-Hart Div.; Crouse-Hinds, Co.
4. Appleton Electric Co.; Emerson Electric Co.
5. Harvey Hubbell, Inc.
6. OZ/Gedney Co.; General Signal Co.
7. Pass and Seymour, Inc.
8. Thomas & Betts Co., Inc.
9. Walker; Wire Mold Company.
10. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

A. Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractor's Association (NECA) "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Install items where indicated and where required to suit code requirements and installation conditions. Cap unused knockout hole where blanks have been removed and plug unused conduit hubs so as to maintain the NEMA rating of the box. Install boxes in locations which ensure ready accessibility to enclosed electrical wiring and avoid installing boxes back-to-back

in walls where there would be less than 6 inches (150 mm) separation. Fasten boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Do not install aluminum products in concrete.

C. Outlet and device boxes for flush-mounted installation shall be a minimum of 4-inch square or octagonal and positioned accurately to allow for surface finish thickness.

D. Junction boxes, pullboxes, and enclosures with hinged doors which are surface-mounted shall utilize spacers to maintain 1/4-inch clearance from the wall.

E. Floor boxes shall be installed level and flush with finish flooring material.

F. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and secure connections when fastened with locknut or bushing on rounded surfaces.

G. Provide electrical connections for installed boxes.

3.2 COORDINATION

A. Coordinate installation of electrical cabinets, boxes, and fittings with wire/cable, wiring devices, and raceway installation work.

3.3 APPLICATIONS

A. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
   1. Use galvanized flat rolled sheet steel boxes only in finished areas.
   2. Use PVC coated steel boxes in corrosive non-hazardous areas as designated on the plans.
   3. Use boxes suitable for the classification in hazardous area as shown on the plans.
   4. Use cast metal boxes in all other locations.

B. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location and in conformance with the following:
   1. Use hot-dipped galvanized steel boxes only in finished areas.
   2. Use stainless steel boxes in corrosive non-hazardous areas and as designated on the plans.
   3. Use boxes suitable for the classification in hazardous area as shown on the plans.
   4. Use NEMA 4X stainless steel or cast metal boxes in all other locations.

C. Enclosures with Hinged Doors: Install enclosures and associated materials and NEMA types suitable for each location and in conformance with the drawings.

D. Floor Boxes: Install cast iron floor boxes at each location indicated.

3.4 GROUNDING

A. General: Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

3.5 CLEANING AND FINISH REPAIR

A. General: Upon completion of installation, inspect components, remove burrs, dirt, and construction debris, and repair damaged finish including chips, scratches, abrasions, and weld marks.

END OF SECTION 26 2716

SECTION 26 2726

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
1. Receptacles.
2. Heavy-duty receptacles.
3. Hazardous location receptacles.
4. Snap switches.
5. Hazardous location snap switches.
6. Wallbox dimming controls.
7. Occupancy sensing light switches.
8. Communications outlets.
9. Covers and wall plates.

B. Related Sections
1. Division 01 Section “Submittal Procedures”.
2. Division 26 Section “Grounding”.
3. Division 26 Section “Electrical Identification”.

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. American National Standards Institute (ANSI)
1. ANSI/IEEE C62.41, IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
2. ANSI/NEMA WD 6, Wiring Devices—Dimensional Requirements.

C. ASTM International (ASTM)
1. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association (NEMA)
1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA Standard FB 11—Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
3. NEMA WD 1, General Color Requirements for Wiring Devices.

E. Telecommunications Industry Association (TIA)
1. TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements.

F. Underwriter's Laboratory (UL)
1. UL 20, Standard for General-Use Snap Switches.
2. UL 498, Standard for Attachment Plugs and Receptacles.
3. UL 894, Standard for Switches For Use In Hazardous (Classified) Locations.
4. UL 943, Standard for Ground-Fault Circuit-Interrupters.
5. UL 1010, Standard for Receptacle-Plug Combinations For Use In Hazardous (Classified) Locations.
6. UL 1203, Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.
7. UL 1449, Standard for Surge Protection Devices.
8. UL 1472, Solid-State Dimming Controls.
9. UL 1682, Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type.
10. UL 1686, Standard for Pin and Sleeve Configurations.
11. UL 1863, Standard for Communications-Circuit Accessories.

1.4 DEFINITIONS

A. Abbreviations
1. AHJ: Authority Having Jurisdiction.
2. NRTL: Nationally Recognized Testing Laboratory.
3. GFCI: Ground-fault circuit interrupting.

B. Finished Locations: The following are defined as finished locations:
1. Areas with carpet or tile floors.
2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
3. Areas with tiled, plastered, or paneled walls.

C. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

D. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

E. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

F. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General
1. Comply with the requirements of Division 01 section, "Submittal Procedures".
2. Submit information as described below.
3. Provide all information necessary to determine compliance.

B. Product Data
   1. Manufacturer's technical product data sheets for all products specified in this section.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Samples: Submit sample of each type and color of wiring device and wall plate.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
   1. All applicable federal, state, and local codes and regulatory requirements.
   2. National Electrical Code (NEC).

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.
   3. All units of the same type must be from the same manufacturer.
   4. Provide nameplates conforming to Division 26 section, "Electrical Identification."

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Provide products listed and labeled by an approved independent NRTL.
   3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 RECEPTACLES

A. General
   1. Brass alloy power contacts and terminal screws.
   2. Side and back wired terminals.
   3. Self-grounding clip on mounting screw.
   4. Thermoplastic back cover.
   5. Nylon face.
   6. Suitable for solid or stranded copper wire.

B. General-Purpose Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL 498.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Single or duplex as shown.

C. GFCI Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL 498, UL 943.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Single or duplex as shown.
   6. Feed-through type.

7. Suitable for mounting in 2-3/4 inch box without adapter.

D. Isolated ground receptacles.
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL498.
   3. Straight blade NEMA WD6, 5-20R.
   4. Brass alloy mounting strap.
   5. Brass allow Isolated ground terminal, and ground contacts.
   6. Identified with orange triangle on face.

E. TVSS Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL498, UL 1449, ANSI/IEEE C62.41 Category A and B.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Integral TVSS in line to ground, line to neutral, and neutral to ground
      a. Multiple metal-oxide varistors.
      b. Nominal clamp level rating of 500 volts.
      c. Minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
   6. Condition indicator light and audible alert.
   7. Distinctive marking on face of device to denote TVSS-type unit.

F. Hospital grade receptacles.
   1. Hospital grade.
   2. NEMA WD 1, NEMA WD 6, UL498.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. Identified with green dot on face.

G. Tamper-resistant receptacles.
   1. [Industrial specification grade][Hospital grade].
   2. NEMA WD 1, NEMA WD 6, UL498.
   3. Straight blade NEMA WD6, 5-20R.
   4. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   5. UL listed as tamper-resistant.
   6. Internal shutter mechanism to limit access to energized components.
   7. Prevents object insertion unless both contacts are engaged.
   8. Identified with green dot on face.
   9. Identified on face as tamper-resistant.

H. Weather-resistant receptacles
   1. Industrial specification grade.
   2. UL listed as weather-resistant.
   3. NEMA WD 1, NEMA WD 6, UL 498.
   4. Ultraviolet light exposure, cold impact, and accelerated aging tests.
   5. Straight blade NEMA WD6, 5-20R.
   6. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   7. Single or duplex as shown.
   8. Identified on face as weather-resistant.

I. Corrosion-Resistant Receptacles
   1. Industrial specification grade.
   2. NEMA WD 1, NEMA WD 6, UL 498.
   3. Pass ASTM B117, 500-hour salt spray test.
   4. Straight blade NEMA WD6, 5-20R.
   5. One-piece brass alloy mounting strap, ground terminal, and ground contacts.
   6. All metal parts nickel-plated.
   7. Nickel-plated mounting screws.
   8. Single or duplex as shown.

J. Receptacle Colors
   1. Normal Power: Ivory.
   2. Emergency Power: Red.
   3. TVSS Protected: Blue.
   4. Corrosion-resistant: Yellow.

K. Available Manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
   1. Hubbell Incorporated.
   2. Leviton Manufacturing Company Incorporated.
   3. Pass & Seymour/Legrand; Wiring Devices Division.

2.3 HEAVY-DUTY RECEPTACLES

A. General
   1. UL 498, UL 1682, UL 1686.
   2. Pin and sleeve type.
   3. Brass contacts.
   4. Cast aluminum body.
   5. Ampere rating as shown.
   6. Attached screw cap.
   7. Suitable for wet locations.
   8. Color coded and configured to a specific circuit voltage and current rating.
   9. Circuit breaking type, arc from disconnecting under load contained with an arc chamber.

B. Accessories
   1. Cast aluminum back box suitable for installed location.
   2. Matching plug for each receptacle.

C. Manufacturers: Subject to compliance, provide products by one of the following.
   1. Appleton.
   2. Arrow-Hart.
   3. Crouse-Hinds.

2.4 RECEPTACLES IN HAZARDOUS (CLASSIFIED) LOCATIONS

A. General
   1. Receptacles rated for specific hazardous locations shown.

B. General purpose receptacle
   1. UL 1010, NEMA WD 6, NEMA 250.

2. NEMA WD6 5-20R.
3. Cast aluminum body.
4. Brass contacts.
5. Factory sealed.
6. Attached cover with hinge and gasket.
7. Suitable for wet locations.
8. Circuit breaking type, plug cannot be removed until disconnecting mechanism rotated.

C. GFCI receptacle
1. UL 943, UL 1010, UL 1203, NEMA WD 6, NEMA 250.
2. NEMA WD6 5-20R.
3. Cast aluminum body.
4. Brass contacts.
5. Factory sealed receptacle.
6. Separate factory sealed GFCI unit.
7. Feed-thru type.
8. Attached receptacle cover with hinge and gasket.
9. Circuit breaking type, plug cannot be removed until disconnecting mechanism rotated.

D. Heavy-duty receptacle
1. UL 1010, UL 1686, NEMA FB 11, NEMA 250.
2. Pin and sleeve type.
3. Brass contacts.
4. Cast aluminum body.
5. Ampere rating as shown.
6. Attached receptacle cover with hinge and gasket.
7. Suitable for wet locations.
8. Color coded and configured to a specific circuit voltage and current rating.
9. Circuit breaking type, arc from disconnecting under load contained with an arc chamber.

E. Accessories
1. Cast aluminum back box suitable for installed location.
2. Matching plug for each receptacle.

F. Available manufacturers. Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Appleton.
2. Crouse-Hinds.

2.5 SNAP SWITCHES

A. General
1. Single-pole, 2-pole, 3-way, 4-way and illuminated handle snap switches as shown.
2. NEMA WD 1, UL 20.

B. Construction
1. Quiet-type alternating current (ac) switches, 20 ampere, 120-277 volt.
2. Side and back wired, screw pressure terminal.
3. Brass alloy terminal screws.
4. Yoke grounding screw.
5. Thermoplastic back cover.

6. Suitable for solid or stranded copper wire.
7. Switch handle color: Ivory.

C. Available Manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Hubbell Incorporated.
2. Leviton Manufacturing Company Incorporated.
3. Pass & Seymour/Legrand; Wiring Devices Division.

2.6 SNAP SWITCHES IN HAZARDOUS (CLASSIFIED) LOCATIONS

A. General
1. UL 20, UL 894, NEMA WD 1, NEMA 250.
2. Rated 20 ampere, 120-277 volt AC.
3. Quiet-type alternating current (ac) switches, 20 ampere, 120-277 volt.
4. Side and back wired, screw pressure terminal.
5. Brass alloy terminal screws.
6. Yoke grounding screw.
7. Thermoplastic back cover.
8. Suitable for solid or stranded copper wire.
9. Cast metal enclosure and cover rated for specific hazardous locations shown.

B. Available manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Appleton.
2. Crouse-Hinds.

2.7 WALLBOX DIMMING CONTROLS

A. General
1. UL 1472.
2. Solid-state full-wave dimmer.
3. Integral, quiet on/off switch, with audible frequency and EMI/RFI suppression filters.
4. Single-pole, 3-way, and 4-way switching.
5. Continuously adjustable slider control.
6. Illuminated when off.

B. Incandescent lamp dimming controls
1. 120 V.
2. Follow square-law dimming curve.
3. Bypass dimmer module with on/off switch positions.
4. Rated wattage: 600 with no de-rating when ganged with other devices.

C. Fluorescent lamp dimming controls
1. Modular; compatible with dimming ballasts.
2. Trim potentiometer to adjust low-end dimming.
3. Dimmer-ballast combination low end dimming down to 20 percent of full brightness.

D. Available manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
1. Lutron.

2. Or approved equal.

2.8 OCCUPANCY SENSING LIGHT SWITCHES

A. Wall-Switch Sensors
   1. Wall box mounted.
   2. Dual voltage (120 and 277 volts).
   3. Dual technology passive-infrared and ultrasonic.
   4. One hundred eighty degree field of view.
   5. Adjustable time delay up to 30 minutes.
   6. Adjustable sensitivity.
   7. Suitable for electronic ballast inrush currents.
   8. Minimum coverage area of 900 square feet.

B. Long-Range Wall-Switch Sensors
   1. Wall box mounted.
   2. Dual voltage (120 and 277 volts).
   3. Passive infrared type.
   4. One hundred ten degree field of view.
   5. Adjustable time delay up to 30 minutes.
   6. Adjustable sensitivity.
   7. Suitable for electronic ballast inrush currents.
   8. Minimum coverage area of 1200 square feet.

C. Wide-Range Wall-Switch Sensors
   1. Wall box mounted.
   2. Dual voltage (120 and 277 volts).
   3. Passive infrared type.
   4. One hundred fifty degree field of view.
   5. Adjustable time delay up to 30 minutes.
   6. Adjustable sensitivity.
   7. Suitable for electronic ballast inrush currents.
   8. Minimum coverage area of 1200 square feet.

D. Exterior Occupancy Sensors
   1. Weatherproof.
   2. Dual voltage (120 and 277 volts).
   3. Passive infrared type.
   4. One hundred eighty degree field of view.
   5. Adjustable time delay up to 15 minutes.
   6. One hundred ten foot detection range.
   7. Suitable for electronic ballast inrush currents.

E. Manufacturers: Subject to compliance, provide products by one of the following:
   1. Hubbell.
   2. Leviton.
   3. Pass & Seymour.
   4. Watt Stopper.

2.9 COMMUNICATIONS OUTLETS

A. Telephone Outlet
   1. UL 1863, TIA/EIA-568-B.1 Category 5e.
   2. One RJ-45 jack.

B. Combination TV and Telephone Outlet
   1. UL 1863, TIA/EIA-568-B.1 Category 5e.
   2. One RJ-45 jack.
   3. One Type F coaxial cable connector.

C. Available manufacturers: Subject to compliance, available manufacturers of the specified products include but are not limited to the following:
   1. Cooper.
   2. Leviton.

2.10 COVERS AND WALL PLATES

A. General
   1. UL 514D.
   2. Single and combination type with ganging and cut-outs as required.
   3. Metal plate-securing screws to match plate finish.

B. Finished Locations
   1. Minimum 0.05 inch thick.
   2. Type 302 satin stainless steel.

C. Other Interior Locations: Galvanized steel.

D. Weatherproof Covers
   1. Rain-proof while in use in compliance with NEC Article 410-57.
   2. Cast aluminum plate with neoprene gasket.
   3. Hinged, self-closing, cast aluminum device cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
   1. Verify outlet boxes are installed at proper locations and heights.
   2. Verify wall openings are neatly cut and will be completely covered by wall plates.
   3. Verify branch circuit wiring is completed, tested, and ready for connection to wiring devices.

B. Discrepancies
   1. Immediately notify the Engineer in writing of conditions detrimental to proper completion of the work.
   2. Correct all unsatisfactory conditions before proceeding with installation.
   3. Resolution must be acceptable to the Engineer.

C. Clean debris from outlet boxes before installing devices.

3.2 INSTALLATION

A. General
1. Install products following manufacturer's instructions.
2. Coordinate with other work, including painting, electrical boxes and wiring installations.
3. Install devices plumb, level, and secure.
4. Mount receptacles in finished areas at 1’-6” above the finished floor.
5. Mount receptacles in all other areas at 4’-0” above the finished floor.
6. Mount all wall switches at 4'-0" above finished floor.
7. Install wiring devices after wiring work is completed.
8. Install wall plates after painting work is completed.
9. Unless otherwise shown, mount devices flush, with long dimension vertical.
10. Group adjacent switches and receptacles under a single, multi-gang wall plate.
11. Do not use the duplex/split-wire break-off tabs in receptacles as circuit conductors for connecting downstream devices.
12. Install receptacles for electric water coolers (EWC) within the cabinet.

B. Dual-Level Lighting Control
1. Provide dual-level lighting control in spaces 100 square feet and larger.
2. Provide controls to reduce the lighting load by at least 50 percent.
3. Coordinate controls to reduce lighting in a reasonably uniform lighting pattern.
4. Coordinate dual-level lighting controls with day lighting apertures, such as windows.

C. Grounding
1. Ground wiring devices as specified in Division 26 section, "Grounding".
2. Connect grounding terminal to branch circuit equipment grounding conductor.

D. Identification: Identify wiring devices as required in Division 26 section, "Electrical Identification”.

3.3 FIELD QUALITY CONTROL

A. Inspections
1. Inspect each wiring device for defects before installing.
2. Have a qualified manufacturer’s representative inspect the installation.

B. Operate each operable device at least six times with circuit energized.

C. Receptacles
1. Test each 20-ampere receptacles for proper polarity and ground continuity.
2. Use a UL listed test device.

D. GFCI Receptacles
1. Test operation according to manufacturer recommendations.
2. Verify that GFCI will trip at 5 ±1 mA current.
3. Verify that GFCI does not trip at less than 1.8 mA current.

E. Replace damaged or defective wiring devices

3.4 ADJUSTING

A. Adjust each occupancy sensor.

B. Occupancy Sensor Time-Out Controls
   1. Utility, lunch/break, storage, and copier rooms: 5-minute time-out setting.
   2. Conference rooms: 10-minute time-out setting.
   3. Corridors and lobbies: 15-minute time-out setting.
   4. All other locations: longest time out setting, but not more than 30 minutes.

C. Ambient Light Sensor: Set to turn off lights when daylighting exceeds 80% of the design illuminance.

3.5 CLEANING

A. General
   1. Clean devices and wall plates.
   2. Replace stained or improperly painted wall plates or devices.
   3. Adjust devices and wall plates to be flush and level.

END OF SECTION 26 2726

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SECTION 26 2813

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install overcurrent protective devices (OCPDs) in accordance with the plans and as specified herein.

B. Work of this Section includes, but is not limited to:
   1. Fuses
      a. Fuses rated 600A and less.
      b. Fuses rated above 600A.
   2. Circuit breakers.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work associated with overcurrent protective devices in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Electrical Component Standard: Components and installation shall comply with National Fire Protection Association (NFPA) 70 "National Electrical Code (NEC)."
   2. Listing and Labeling: Provide products specified in this section that are listed and labeled (as defined as they are in the NEC, Article 100).
   3. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.

B. Single Source Responsibility: Obtain similar OCPDs from a single manufacturer.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submittals: Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product data for fuses, circuit breakers, and OCPD accessories specified in this section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

C. Reference Submittals
   1. Manufacturer's descriptive literature.
   2. Operating and maintenance instructions.
   3. Spare parts list.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver OCPDs and components in factory fabricated type containers or wrappings, which properly protect devices from damage.

B. Handle OCPDs carefully to prevent physical damage to OCPDs and components. Do not install damaged OCPDs; remove from site and replace damaged devices with new.

C. Store OCPDs in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

1.6 DEFINITIONS

A. OCPD: A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

B. Ampere Squared Seconds: An expression of available thermal energy resulting from current flow. With regard to current limiting fuses and circuit breakers, the ampere squared seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General
   1. Provide OCPDs in indicated types, as integral components of panelboards, switchboards, and motor control centers; and also as individually enclosed and mounted single units.
   2. Enclosures: National Electrical Manufacturers Association (NEMA) 250 "Enclosures for Electrical Equipment (1,000 volts Maximum)."

B. Cartridge Fuses
   1. NEMA Standard FU1, "Low Voltage Cartridge Fuses": Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used.
   2. Class J Fuses: Underwriters' Laboratories, Inc. (UL) 198C, "High Interrupting Capacity Fuses, Current Limiting Type".
   3. Class L Fuses: UL 198C, "High Interrupting Capacity Fuses, Current Limiting Type".
   4. Class RK1 and RK5 Dual Element Time Delay Fuses: UL 198E, "Class R Fuses".
   5. Provide a complete set of fuses for all fusible equipment on the job.
   6. All fuses shall be of the same manufacturer and shall have an interrupting rating of 200,000 A, RMS symmetrical, except where otherwise noted.
   7. All fuses shall bear UL label and class designation.
   8. Place fuse identification labels showing size and type of fuse installed inside the cover of each switch or piece of equipment.

9. Fuse voltage shall be as required for the service.
10. Fuses Rated 600A and Less
    a. Fuses which protect motor circuits and transformers shall be time delay type, UL Listed, Class RK-1, except where otherwise noted.
    b. Fuses which are protecting circuit breakers, circuit breaker panels, and resistive heating circuits shall be fast-acting, current limiting type, UL listed, Class J, except where otherwise noted.
11. Fuses Rated Above 600 A
    a. Fuses which protect motor circuits shall be time delay, current limiting type, UL listed, NEMA Class L, except where otherwise noted.
    b. Fuses which are protecting circuit breakers, circuit breaker panels, and resistive heating circuits shall be fast-acting, current-limiting type, UL listed, class L.

C. Circuit Breakers
1. Molded case type, with ampere rating, frame size and number of poles as shown.
2. Comply with the following:
    a. UL 489 "Molded Case Circuit Breakers and Circuit Breaker Enclosures."
    b. NEMA AB 1 "Molded Case Circuit Breakers."
    c. Federal Specification W-C-375.
3. Bolt in type, except breakers 225 ampere frame size and larger may be plug in type if held in place by positive locking device requiring mechanical release for removal.
4. Minimum RMS symmetrical short circuit interrupting capacity rating.
    a. 10,000 Amperes at 120/240V.
    b. 18,000 amperes at 277V.
    c. 35,000 amperes at 480V.
5. Quick make, quick break toggle mechanism.
6. Inverse time-current characteristic overload protection for each pole.
7. Instantaneous magnetic trip element short circuit protection for each pole.
8. Solid state trip device for circuit breaker frame sizes over 250 Amperes.
    a. Independently adjustable long time, short time, and instantaneous trip settings.
    b. Ground fault trip unit where shown, adjustable for pick up and time delay.
    c. Settings adjustable from front of breaker controls and/or plug-in element change.
    d. Indicator for cause of trip.
9. Provide circuit breakers appropriate for applications, including Type SWD for switching fluorescent lighting loads, and Type HACR for heating, air-conditioning, and refrigeration equipment.

D. OCPD Accessories
1. Provide key interlocks where shown.
    a. Arrange interlocking so keys are held captive at devices indicated.
    b. Where future key interlocking provisions are indicated, provide necessary mountings and hardware as required for the future installation.
2. Labels: Install label inside enclosure identifying the type of OCPD installed, its overcurrent rating, its interrupt rating and UL class. Where applicable, trip settings and time delays should be provided on permanent labels.

E. Extra Materials: For types and ratings required, furnish spare fuses, amounting to one fuse for every five installed fuses, but not less than one set of three of each type of fuse.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:
   1. Cartridge Fuses
      a. General Electric Co.
      b. Littelfuse Inc., Tracor, Inc.
   2. Molded Case Circuit Breakers
      a. Eaton Corporation.
      b. General Electric Company.
      c. Square D Company.
      d. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
   1. Install fuses and circuit breakers as indicated, in accordance manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with the NEC, and NEMA Standards.
   2. Inspect each circuit breaker and fuse visually.
   3. Perform several mechanical ON-OFF operations on each circuit breaker and switch.
   4. Verify circuit continuity on each pole in closed position.

B. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions.

C. OCPDs in distribution equipment shall be factory installed.

3.2 IDENTIFICATION

A. Identify components in accordance with Division 26, Section “Electrical Identification”.

3.3 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and UL 486B.

3.4 GROUNDING

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.5 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Include the following inspections and related work.
   1. Overcurrent Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make the final system adjustments.
   2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
   3. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
   4. Check tightness of electrical connections of OCPDs with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   5. Clean OCPDs using manufacturer's approved methods and materials.
   6. Verify installation of proper fuse types and ratings in fusible OCPDs.

3.6 CLEANING

A. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.7 DEMONSTRATION

A. Training: Arrange and pay for the services of factory authorized service representatives to demonstrate OCPDs and train Owner's maintenance personnel.

B. Conduct a minimum of one half day of training in operation and maintenance as specified under "Instructions to Owner Employees" in the "Project Closeout" section of these specifications. Include both classroom training and hands-on equipment operation and maintenance procedures.

C. Schedule training with at least 7 days' advance notification.

END OF SECTION 26 2813

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SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
   1. Service disconnecting means.
   2. Feeder and branch-circuit protection.
   3. Equipment disconnecting means.
   4. Motor circuit disconnecting means.

B. Related Sections
   1. Division 01 Section “Submittal Procedures”.
   2. Division 01 Section “Operation and Maintenance Data”.
   3. Division 26 Section “Electrical Identification”.
   4. Division 26 Section “Overcurrent Protective Devices”.

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. Underwriter's Laboratory, Inc. (UL)
   1. UL 98, Enclosed and Dead Front Switches.
   2. UL 486A-486B, Wire Connectors.

C. InterNational Electrical Testing Association (NETA)
   1. ATS, Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.

D. National Electrical Manufacturers Association (NEMA)
   1. NEMA KS 1, Enclosed Switches.
   2. NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   3. NEMA AB1, Molded Case Circuit Breakers.

E. National Fire Protection Association (NFPA)
   1. NFPA 70, National Electrical Code (NEC).

1.4 DEFINITIONS

A. Abbreviations
   1. AHJ: Authority having jurisdiction.
   2. NRTL: Nationally recognized testing laboratory.

B. Interior Locations: The following are defined as interior locations:
   1. Any location within the boundaries of the foundation of any building.
   2. Any location within the superstructure of other structures not classified as buildings.

C. Wet Locations: The following are defined as wet locations:
   1. All exterior locations.
   2. All interior locations below grade.
   3. All interior locations where wet materials are processed, pumped, transported, or stored.

D. Corrosive Locations: The following are defined as corrosive locations.
   1. All locations with chemical feed/transfer equipment
   2. All locations with chemical storage tanks
   3. All locations where chemical storage drums are located.

E. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
   1. All hazardous (classified) locations and their hazard classification are shown.

F. Seismic Withstand: When subjected to the specified seismic forces, seismic withstand means:
   1. The unit will remain in place.
   2. No parts will separate from the unit.
   3. The unit will be fully operational after the seismic event.

1.5 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information needed to determine compliance.

B. Product Data
   1. Manufacturer’s technical product data sheets.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
   1. Dimensional drawings for enclosures.
   2. Time-current curves, including selectable ranges for each type of circuit breaker.
   3. Wiring Diagrams: Submit wiring diagrams for all products.
      a. Show all components and features specified.
      b. Differentiate between factory installed and field installed wiring and components.

D. Quality Control Submittals
   1. Manufacturer Seismic Qualification Certification
      a. Submit certification that products will withstand seismic forces defined in Division 26 section, "Seismic Controls for Electrical Work."
      b. Indicate whether certification is based on actual testing calculation.
      c. Identify center of gravity and locate and describe mounting and anchorage provisions on a dimensioned outline drawing.
      d. Provide description of equipment anchorage devices on which certification is based and their installation requirements.
   2. Qualification Data: Submit compliance data for testing agencies.

3. Manufacturer’s Instructions. Submit manufacturer's current installation instructions.

E. Contract Closeout Submittals
1. Project record documents.
2. Operation and Maintenance (O&M) Data
a. Comply with Division 01 section, "Operation and Maintenance Data."
b. Include instructions on start-up, operation, and maintenance.
c. Manufacturer's instructions for testing and adjusting switches and circuit breakers.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Perform all work in compliance with the following:
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

B. Testing Agency Qualifications
1. Member of NETA.
2. Acceptable to authorities having jurisdiction.
3. Field Supervisor currently certified by the NETA.

C. Product Selection for Restricted Space
1. Drawings indicate maximum dimensions for enclosed switches and circuit breakers.
2. Comply with indicated maximum dimensions.

1.7 MAINTENANCE

A. Extra Materials: Provide extra materials described below:
1. Match products installed.
2. Packaged with protective covering for storage.
3. Identified with labels describing contents.
4. Fuses: Provide 3 fuses of each size used on project.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
1. Provide new and unused products of current manufacture.
2. Provide products free from defects affecting performance.
3. All units of the same type must be from the same manufacturer.

B. Listing and Labeling
1. Provide UL listed and labeled products.
2. Provide products listed and labeled by an approved independent NRTL.
3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.
4. Provide a service equipment label on all switches and circuit breakers used as a service disconnecting means.

2.2 MANUFACTURERS

A. Subject to compliance, provide products by one of the following:

1. Cutler-Hammer.
2. Square D Company.
3. Or approved equal.

2.3 ENCLOSED SWITCHES

A. General
1. NEMA KS 1, UL-98.
2. Heavy duty safety switch.
3. Quick make, quick break mechanism.
4. Switch blades visible in OFF position with door open.
5. High conductivity copper current carrying parts and silver tungsten switch contacts.
6. Rated for 60 and 75 degree Celsius wire.

B. Operating Handle
1. Handle down in the off position.
2. Pad-lockable in off position with up to three padlocks.
3. Interlocked with cover to prevent opening cover with switch in closed position.
4. Inconspicuous interlock defeat mechanism.

C. Fusible Switches
1. Positive-pressure reinforced fuse clips.
2. Class R rejection type.
3. Fuses as shown and as specified in Division 26 Section “Overcurrent Protective Devices”.

D. Accessories
1. Neutral lug kit.
2. Ground lug.
3. Auxiliary contact.

2.4 ENCLOSED CIRCUIT BREAKERS

A. General
1. Molded case circuit breaker as shown and as specified in Division 26 Section “Overcurrent Protective Devices”.
2. NEMA AB 1.
3. Mechanical lugs sized for quantity, size, and type of conductors shown on the drawings.
4. Shunt trip coil
    a. Where shown on the drawings.
    b. 120 V energized from separate circuit.
    c. Set to trip at 75 percent of rated voltage.

B. Operating Handle
1. Handle down in the off position.
2. Pad-lockable in off position with up to three padlocks.
3. Interlocked with cover to prevent opening cover with switch in closed position.
4. Inconspicuous interlock defeat mechanism.

C. Accessories
1. Neutral lug kit.

2. Ground lug.
3. Auxiliary contact.

2.5 ENCLOSURES

A. General
1. Wet Locations: NEMA 250, Type 4X stainless steel.
2. Corrosive Areas: NEMA 250, Type 4X non-metallic.
3. Class 1 Hazardous Locations: NEMA 250 Type 7 cast aluminum.
4. All Other Locations: NEMA 250, Type 12 painted steel.

B. Finish: Manufacturer's standard paint factory applied before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
1. Examine surfaces that will receive the enclosed switches and circuit breakers.
2. Verify that the project has progressed to a point where this installation may begin.

B. Discrepancies
1. Immediately notify the Engineer in writing is any discrepancies are found.
2. Resolve all discrepancies before proceeding with installation.
3. Resolution must be acceptable to the Engineer.

3.2 PREPARATION

A. Surface Preparation
1. Carefully lay out the work in advance.
2. Perform any cutting, drilling, etc. without damaging the building surfaces or equipment.

B. Rough-in
1. Refer to equipment submittals for rough-in requirements.
2. Verify rough-in locations by field measurements.

3.3 INSTALLATION

A. General
1. Comply with the manufacturer's installation instructions.
2. Install enclosed switches and circuit breakers where shown.
3. Locations shown are approximate unless dimensioned.
4. Coordinate layout and installation with other construction, including conduit.
5. Maintain required workspace clearance.
6. Install motor disconnecting means within sight of the motor.
7. Provide suitable means for mounting enclosed switches and circuit breakers.
8. Remove temporary lifting means and blocking of moving parts.
9. Comply with mounting and anchoring requirements of in Division 26 section, "Seismic Controls for Electrical Work."

B. Connections

1. Tighten connectors and terminals according to manufacturer published torque values.
2. Where manufacturer torque values are not indicated, follow UL 486A-486B.
3. Provide effective and permanent grounding connections.

C. Identification
1. Identify field-installed conductors, interconnecting wiring, and components.
2. Provide warning signs as specified in Division 26 section, "Electrical Identification."
3. Label each enclosure as specified in Division 26 section, "Electrical Identification."

3.4 FIELD QUALITY CONTROL

A. Prepare for Acceptance Tests
1. Test insulation resistance for each enclosed switch and circuit breaker.
2. Test continuity of each line- and load-side circuit.

B. Testing
1. Do not start testing until enclosed switches and circuit breakers are installed and electrical circuitry has been energized.
2. Demonstrate product capability and compliance with requirements.
3. Perform visual and mechanical inspection and electrical test indicated in:
   a. NETA ATS, Section 7.5 for switches.
   b. NETA ATS, Section 7.6 for molded-case circuit breakers.
4. Certify compliance with test parameters.
5. Correct malfunctioning units on-site, where possible.
6. Retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Infrared Scanning
1. Perform an infrared scan of each enclosed switch and circuit breaker.
2. Perform scans after Substantial Completion, but before Final Acceptance.
3. Open or remove doors or panels so connections are accessible to portable scanner.
4. Perform a follow-up scan of each unit 11 months after date of Substantial Completion.
5. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
6. Provide calibration record for device.
7. Prepare certified report identifying equipment checked and describing scanning results.
8. Note deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Set field-adjustable circuit-breaker trip ranges.

3.6 CLEANING

A. General
1. After completing installation, inspect interior and exterior of enclosures.
2. Remove paint splatters and other spots.
3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
4. Repair exposed surfaces to match original finish.

END OF SECTION 26 2816

SECTION 26 2913

MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes
1. Manual motor controllers.
2. Magnetic motor controllers.
3. Combination magnetic motor controllers.
4. Solid-state reduced voltage motor controllers.

B. Related Sections
1. Division 01 Section “Submittal Procedures”.
2. Division 01 Section “Operation and Maintenance Data”.
3. Division 26 Section “Basic Electrical Requirements”.
4. Division 26 Section "Basic Electrical Materials and Methods."
5. Division 26 Section “Grounding”.
6. Division 26 Section “Supporting Devices”.
7. Division 26 Section “Electrical Identification”.
8. Division 26 Section “Control Devices”.
9. Division 26 Section “Overcurrent Protective Devices”.
10. Division 26 Section "Motor Controllers."

1.3 REFERENCES

A. Unless otherwise stated, references are to the latest edition of the standard.

B. Underwriter's Laboratory (UL)
1. UL 508, "Standard for Industrial Control Equipment."

C. National Electrical Manufacturers Association (NEMA)
1. NEMA 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."
2. NEMA ICS 2, "Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts."

1.4 DEFINITIONS

A. Abbreviations
1. AHJ: Authority having jurisdiction.
2. NRTL: Nationally recognized testing laboratory.
3. SPDT: Single pole double throw.

B. Seismic Withstand: When subjected to the specified seismic forces, seismic withstand means:
   1. The unit will remain in place.
   2. No parts will separate from the unit.
   3. The unit will be fully operational after the seismic event.

C. Finished Locations: The following are defined as finished locations:
   1. Areas with carpet or tile floors.
   2. Areas with lay-in ceiling tile, fixed ceiling tile, and special architectural ceiling treatment.
   3. Areas with tiled, plastered, or paneled walls.

D. Interior Locations: The following are defined as interior locations:
   1. Any location within the boundaries of the foundation of any building.
   2. Any location within the superstructure of other structures not classified as buildings.

E. Wet Locations: The following are defined as wet locations:
   1. All exterior locations.
   2. All interior locations below grade.
   3. All interior locations where wet materials are processed, pumped, transported, or stored.

F. Corrosive Locations: The following are defined as corrosive locations.
   1. All locations with chemical feed/transfer equipment
   2. All locations with chemical storage tanks
   3. All locations where chemical storage drums are located.

G. Hazardous (Classified) Locations: The following are defined as hazardous (classified) locations.
   1. All hazardous (classified) locations and their hazard classification are shown.

1.5 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information necessary to determine compliance.

B. Product Data
   1. Manufacturer’s technical product data sheets for all products specified in this section.
   2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawings
   1. Materials List: Submit a list with quantities, manufacturer’s name, and catalog numbers.
   2. Dimensional Drawings: Submit dimensional drawings for all products.
   3. Wiring Diagrams: Submit wiring diagrams for all products.
      a. Show all components and features specified.
      b. Differentiate between factory installed and field installed wiring and components.

D. Quality Control Submittals
   1. Test Reports
      a. Factory test report: Submit results of the required factory test prior to shipment.
      b. Field test report: Submit certified copies of the field test reports.
   2. Manufacturer’s Instructions: Submit manufacturer's current installation instructions.
   3. Manufacturer’s field reports.

4. Training data.

E. Contract Closeout Submittals
1. Project record documents.
2. Operation and Maintenance (O&M) Data
a. Submit O&M manual prior to delivery of the products.
b. Comply with Division 01 Section “Operation and Maintenance Data”.
c. Include instructions on start-up, operation, and maintenance.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
1. All applicable federal, state, and local codes and regulatory requirements.
2. National Electrical Code (NEC).

1.7 MAINTENANCE

A. Extra Materials
1. Maintenance stock of fuses amounting to one unit for every installed unit.
2. One main control board for every three solid-state reduced voltage controllers provided.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
1. Provide new and unused products of current manufacture.
2. Provide products free from defects affecting performance.
3. Provide units of the same type all made by the same manufacturer.
4. Provide nameplates complying with Division 26 Section “Electrical Identification”.

B. Listing and Labeling
1. Provide UL listed and labeled products.
2. Provide products that have been listed and labeled by an approved independent NRTL.
3. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 MANUAL CONTROLLERS

A. Manual Controllers
1. Sizes and ratings as indicated on the drawings.
2. Manually operated quick make, quick break toggle mechanism.
3. One piece melting alloy type thermal overload unit.
4. Controller inoperative when thermal unit removed.
5. Green pilot light.
6. Capable of being padlocked in the OFF position.

2.3 MAGNETIC CONTROLLERS

A. Magnetic Contactors
1. Three pole unless otherwise shown.
2. Sizes as shown.

3. NEMA ICS 2 and UL 508.
4. Integral NEMA sizes, minimum size 1.
5. Coil rated for 120 Volts unless otherwise shown.
6. Double break silver-alloy contacts.

B. Full Voltage Non-Reversing (FVNR) Magnetic Controllers
1. Magnetic contactor as specified above.
2. NEMA sizes as shown.
3. Solid-state overload relay as specified in article "ACCESSORIES" below.
4. Control power transformer as specified in article "ACCESSORIES" below.
5. Enclosure as specified in article "ACCESSORIES" below.

C. Full Voltage Reversing (FVR) Magnetic Controllers
1. Two magnetic contactors as specified above.
2. NEMA sizes as shown.
3. Contactors electrically and mechanically interlocked to prevent simultaneous closing.
4. Solid-state overload relay as specified in article "ACCESSORIES" below.
5. Control power transformer as specified in article "ACCESSORIES" below.
6. Enclosure as specified in article "ACCESSORIES" below.

D. Two-Speed Two-Winding Magnetic Controller
1. Two magnetic contactors as specified above.
2. NEMA sizes as shown.
3. Contactors electrically and mechanically interlocked to prevent simultaneous closing.
4. Two solid-state overload relays as specified in article "ACCESSORIES" below.
5. Control power transformer as specified in article "ACCESSORIES" below.
6. Enclosure as specified in article "ACCESSORIES" below.

2.4 SOLID-STATE CONTROLLERS

A. Solid-State Reduced Voltage Controllers (SSRV)
1. Provide types, ratings, and NEMA sizes as shown on the Contract Drawings.
2. Suitable for use with standard 3 phase squirrel cage induction motors.
3. Silicon controlled rectifiers (SCRs) for controlling motor voltages during acceleration.
4. On-board diagnostics with light emitting diodes (LEDs) to indicate fault conditions.
5. Isolated, convertible SPDT fault contact output for remote indication.
6. Adjustable current limit.
7. Solid-state overload relay as specified in article "ACCESSORIES" below.
8. Closed loop feedback system to maintain motor acceleration at constant rate.
9. Magnetic contactors as specified above.
    a. Bypass contactor.
    b. Input isolation contactor.
    c. Contactor for isolating power factor correction capacitors from SCRs.

2.5 COMBINATION CONTROLLERS

A. General
1. Motor controller, short-circuit protection, and disconnecting means.
2. Controller as described above (i.e., FVNR, FVR, SSRV).

B. Short-Circuit Protection

1. Fuse, molded-case circuit breaker, or motor circuit protector as shown.
2. As specified in Division 26 Section “Overcurrent Protective Devices”.

C. Disconnecting Means
1. External operating handle with an up-down motion and down position indicating OFF.
2. Lockable in the OFF position with up to three padlocks.

2.6 ACCESSORIES

A. General
1. Mount all accessories in the controller enclosure.
2. If an additional enclosure is required, obtain approval from the Engineer.
3. Construct any additional enclosures equal to the controller enclosure.
4. Provide all required interconnections between the enclosures.
5. Provide equipment nameplates complying with Division 26 Section “Electrical Identification”.

B. Solid-State Overload Relay
1. Current sensor in each phase.
2. Switch selectable for the specific motor full load amperes within the starter range.
3. Running overload protection with time-current characteristics closely paralleling that the motors heating damage boundary
4. Accurate to 2 percent.
5. Selectable overload trip class, 5, 10, 15, 20, and 30.
6. Phase failure protection.
7. Current unbalance trip setting adjustable from 10 to 50 percent.
8. Voltage unbalance trip setting adjustable from 5 to 20 percent.
9. Conformally coated to provide corrosion resistance.

C. Control Power Transformer
1. Provide a control power transformer for each motor controller.
2. Secondary voltage to match coil voltage specified above.
3. Provide control power transformers as specified in Section 260900, Control Devices.
4. Size transformer as required to provide adequate capacity to operate the following:
    a. Motor controller contactor coil.
    b. All other devices connected to the control circuit as shown.

D. Control Components
1. As specified in Division 26 Section “Control Devices”.
2. Type and quantity of control components as shown.
3. For spare controllers or where not shown, provide the following:
    a. Hand-Off-PLC selector switch.
    b. Elapsed time meter.
    c. Green run light.

E. Enclosures.
1. NEMA 250, Type 4X in corrosive locations.
2. NEMA 250, Type 4X in wet locations.
3. NEMA 250, Type 7 in Class I hazardous locations.
4. NEMA 250, Type 12 in all other locations.

2.7 MANUFACTURERS

A. Manufacturers: Subject to compliance, provide product manufactured by one of the following:
   1. Allen-Bradley.
   2. Cutler Hammer.
   3. Square D.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions
   1. Inspect installed work prior to performing the work of this section.
   2. Verify that the project has progressed to a point where this installation may begin.

B. Material inspection.

C. Discrepancies
   1. Immediately notify the Engineer in writing of conditions detrimental to proper completion of the work.
   2. Correct all unsatisfactory conditions before proceeding with installation.
   3. Resolution must be acceptable to the Engineer.

3.2 PREPARATION

A. Surface Preparation
   1. Carefully lay out the work in advance.
   2. Perform any cutting, drilling, etc. without damaging the building surfaces or equipment.

B. Rough-in
   1. Refer to equipment submittals for rough-in requirements.
   2. Verify rough-in locations by field measurements.

3.3 INSTALLATION

A. General
   1. Conform to submittal data.
   2. Conform to arrangements indicated.

3.4 FIELD QUALITY CONTROL

A. Inspecting and adjusting
   1. Provide a manufacturer trained technician to inspect and adjust the equipment.
   2. Adjust motor overload trip setting and class to match motor nameplate.
   3. Adjust voltage and current unbalance settings to protect motor without nuisance trips.
   4. Adjust acceleration and deceleration times to prevent pressure surges in water lines.
   5. Make other adjustments to solid state controllers as required for proper operation.

B. After completion of all inspections, perform field testing.

C. Training

1. Train the Owner's personnel in the operation and maintenance of the products.
2. Complete all testing and adjustments before starting on training.
3. Provide for the services of a manufacturer's representative to perform the training.
4. Provide for a minimum of 4 hours of training for 6 people.

END OF SECTION 26 2913

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SECTION 26 2923

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General
   1. Drawings and general provisions of Contract.
   2. General and Supplementary Conditions.
   3. Division 01 Specification Sections.

B. Related Sections. The following sections contain requirements that relate to this section:
   1. Division 26 Section “Motor Control Centers”.
   2. Division 26 Section “Overcurrent Protective Devices”.
   3. Division 26 Section “Control Devices”.
   4. Division 40 Section “Instrumentation – General”.

1.2 DESCRIPTION OF WORK

A. Scope of Work.
   1. Extent of variable frequency drive work is shown on the drawings and specified herein.
   2. Provide all labor, materials, tools, and equipment necessary to perform the work.

B. Section Includes. Materials and equipment specified in this section include the following:
   1. Variable Frequency Drives (VFDs).
   2. Drive Accessories.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements
   1. National Electrical Code (NEC).
   2. All applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
   1. National Fire Protection Association (NFPA).
   2. Underwriters' Laboratories, Inc. (UL).
   3. Institute of Electrical and Electronic Engineers (IEEE).
   4. National Electrical Manufacturers Association (NEMA).

C. Qualifications
   1. Manufacturer: Firms engaged in the manufacture of VFDs for not less than 5 years.

1.4 SUBMITTALS

A. Product Data
   1. Manufacturer’s technical product data sheets for the VFD and all accessories.
   2. Delete or cross out all inappropriate or non-applicable information.

B. Shop Drawings
   1. Dimensional drawings showing enclosure size and arrangement of all components.
   2. Wiring diagrams in ladder logic form with terminal and wire numbers. Differentiate between factory installed and field installed wiring and components.
   3. Indicate job name, Owner, location, and date on all shop drawings.

C. Material list giving quantities, manufacturer's name, and catalog numbers.

D. Operation and Maintenance (O&M) Manual with the following:
   1. Maintenance data.
   2. Parts list.
   3. Troubleshooting guide.
   4. Product data
   5. Wiring diagrams.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs and accessories packaged in factory fabricated containers.

B. Store VFDs and accessories in a clean dry space.

C. Handle variable frequency drives and accessories carefully to avoid damage.

D. Return damaged units to equipment manufacturer and replace with new units.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES.

A. General
   1. Provide VFDs of sizes, ratings, and torque characteristics required by the driven equipment.
   2. Provide listed and labeled controllers and components.
   3. All drives on the project shall be the same manufacturer and series/class.
   4. Comply with the following:
      a. NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies,"
      b. NEMA Standard ICS 3.1, "Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems."
      c. NEMA Pub No.250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."
      d. UL 508C
   5. Provide drives suitable for use with standard squirrel-cage induction motors having a 1.10 service factor.
   6. Construction
      a. Full wave 6-pulse rectifier section.
      b. Direct current (dc) filter section
      c. Pulse width modulated (PWM) inverter section.

B. Features
   1. Designed to shut down without damage under the following conditions:
      a. Short circuit.

b. Overcurrent.
c. Over voltage.
d. Under voltage.
e. Loss of phase.
f. Over-speed.
g. Power unit over-temperature.

2. Selectable sensor-less vector or Volts per Hertz operating modes.
3. Multiple programmable stop modes including: ramp, coast, dc brake, ramp-to-hold, and s-curve.
4. Energy saving mode to automatically reduce output voltage to a lightly loaded motor.
5. Built-in process control algorithm.
6. Electronic motor overload protection.
7. Input line fuses.
8. Output voltage regulator.
9. Status LEDs for power and communications.
10. Door mounted operator interface with the following features:
    a. Membrane keypad with keys for the following:
        1) Drive programming.
        2) Numeric.
        3) Stop and stop.
        4) Automatic/Manual.
        5) Speed increase/decrease.
    b. Back-lit seven-line, 21 character LCD display.
11. Drive parameters stored in EEPROM and re-settable through the keypad.
12. Password security.
13. Process signal inverter to allow speed of drive to vary inversely with input signal.
14. Three programmable skip frequencies.
15. Capable of picking up a load spinning in either direction without tripping drive.
16. All components factory mounted and wired.
17. User programmable inputs and outputs (I/O).
    a. Minimum of two analog inputs, 4-20 mA, isolated.
    b. Minimum of two analog outputs, 4-20 mA, isolated.
    c. Minimum of six digital inputs, and two relay outputs.
18. Ethernet/IP communications.

C. Sizes and Ratings
1. Input Voltage: 480 Volt, three-phase, ±10%.
2. Input Frequency: 60 Hertz (Hz), ±3 Hz.
3. Displacement Power Factor: Between 1.0 and 0.95 lagging.
4. Efficiency: Greater than 96 percent.
5. Output Voltage: Three phase, variable from 0 to 460V.
6. Output Frequency: Variable from 6 to 400 Hz, minimum.
7. Speed Range: 10:1, step-less.
8. Acceleration/Deceleration Rate: Adjustable from 0 to 3600 seconds.
9. Minimum Frequency: Adjustable from 6 to 30 Hz.
10. Maximum Frequency: Adjustable from 60 to 120 Hz.
11. Current Limit: Adjustable from 100 to 150 percent.
12. PWM Carrier Frequency: Adjustable from 2 to 10 kHz.
13. Ambient Temperature Range: 0 to 40 degrees Celsius.
14. Relative Humidity Limit: 95 percent non-condensing.
15. Constant Torque / Heavy Duty rated (125% of installed motor FLA)

2.2 ACCESSORIES.

A. Control Components
   1. As specified in Division 26 Section "Control Devices," and as shown on the drawings.
   2. If not otherwise shown, provide a Hand-Off-PLC selector switch, fused control power transformer, green run pilot light, and red fault light.

B. Enclosures
   1. Configured as motor control center unit compartment where shown as part of a motor control center.
   2. Mount VFDs in NEMA Type 12 enclosures where not shown as part of a motor control center.
   3. Coat the enclosures with the manufacturer's standard color finish.

C. Drive Accessories
   1. Input line reactor, 3 percent impedance.
   2. Input isolation contactor.
   3. Output dV/dt filter.

2.3 EQUIPMENT/SYSTEM IDENTIFICATION

A. Provide equipment/system identification nameplates complying with Division 26, Section “Electrical Identification”.

2.4 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide VFDs by one of the following:
   1. Allen-Bradley Company.
   2. Eaton Corporation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. General
   1. Examine areas where VFDs are to be installed.
   2. Notify the Engineer in writing of conditions detrimental to proper completion of the work.
   3. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.2 INSTALLATION

A. General
   1. Install VFDs in accordance with the manufacturer's written instructions and recognized industry practices.
   2. Comply with requirements of NEC, UL and NEMA standards.
   3. Install fuses of sizes indicated in each fusible disconnect switch.
   4. Tighten connectors and terminals in accordance with manufacturer requirements, UL Standards 486A/486B, and the NEC.

B. Grounding
   1. Provide equipment grounding connections for VFDs and enclosure as indicated.
   2. Tighten connections to comply with tightening torque specified in UL Standard 486A/486B.

C. Start-up and Programming
   1. Upon completion of the VFD installation, provide for the services of a certified factory service technician to inspect and approve the installation and to program and start-up the drives.
   2. Program the drive command, set-up, and motor parameter settings to match the requirements of the motor, the control diagrams and control descriptions.
   3. All drive communication programming shall be provided by the System Integrator under Division 40, Section "Instrumentation – General". Provide any information necessary to allow the System Integrator to perform the required programming. Programming shall include all network addressing and the reading from or writing to of a minimum of eight registers in each drive.

D. Testing
   1. Provide all equipment required for testing, start-up and performance verification.
   2. Testing shall be witnessed by the Engineer. The Engineer shall be notified at least 48 hours in advance of testing. The current and voltage and power factor shall be monitored at the motor control center or switchboard feeding the controller being tested. Data shall be collected for each motor at rated load and speed with all motors running at rated load and speed.
   3. Prior to energizing of motor controllers, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure manufacturer's requirements are met. Units not acceptable shall be replaced.
   4. Harmonic Testing. Testing shall be witnessed by the Engineer. The Engineer shall be notified at least 48 hours in advance of testing. The current and voltage harmonic distortion and power factor shall be monitored at the motor control center or switchboard feeding the controller being tested with a BMI Model 3030 harmonic analyzer or equal. Data shall be collected for each motor at rated load and speed with all motors running at rated load and speed. Sufficient data shall be collected to prepare a report to compare the harmonic content of the system to the calculated values in the analysis submitted in accordance with Part 1 of this specification.

3.3 FIELD QUALITY CONTROL

A. General
   1. Prior to energizing the drives, check the phase-to-phase and phase-to-ground insulation resistance levels with ground resistance tester to ensure that requirements are fulfilled.
   2. Prior to energizing, check circuitry for electrical continuity and for short circuits.
   3. Verify that direction of rotation of each motor is correct.

B. Operational Demonstration
   1. Upon completion of installation of the VFDs, energize drive circuitry and demonstrate proper functioning of the equipment in accordance with requirements.
   2. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

3.4 TRAINING

A. General
   1. Provide for the services of a manufacturer-trained and certified representative to train the Owner's personnel in the proper operation and maintenance of the VFDs.
   2. Provide training for a minimum of 6 people.
   3. Total training time shall be 4-hours minimum per person.

B. Topics covered shall include:
   1. Safety.
   2. Keypad/display interface.
   3. Programming, setup, and configuration.
   4. Operational indicators.
   5. Faults, diagnostic tools, troubleshooting, and preventive maintenance.

C. Provide documentation for each attendee including equipment manuals, drawings and schematics of equipment supplied for this project.

3.5 ADJUSTING AND CLEANING

A. Adjust operating mechanisms, where necessary, for free mechanical movement.

B. Touch up scratched or marred enclosure surfaces to match original finishes.

END OF SECTION 26 2923

SECTION 26 3213

DIESEL ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

B. Related Sections
   1. Division 26 Sections.

1.2 DESCRIPTION OF WORK

A. General: Provide all professional services, labor, tools, equipment, and materials necessary for a complete and functional engine-generator system in accordance with the Drawings and as specified herein

B. Types of equipment specified in this section include:
   1. Engine-generator set
   2. Batteries
   3. Battery charger
   4. Exhaust system
   5. Sub-base fuel tank
   6. Weatherproof/Sound Attenuating Enclosure and anchorage to foundation
   7. Door access stairs and platforms and anchorage to foundation

C. Applications for the engine-generator power supply are:
   1. Plant equipment operation

1.3 QUALITY ASSURANCE

A. Codes: Perform all work in compliance with the following:
   1. All applicable federal, state, and local codes and regulatory requirements.
   2. National Electrical Code (NEC).

B. Standards
   1. National Fire Protection Association (NFPA).
   2. Underwriters' Laboratories, Inc. (UL).
   3. American National Standards Institute (ANSI).
   4. National Electrical Manufacturers Association (NEMA).
   5. Institute of Electrical and Electronic Engineers (IEEE).

C. Qualifications
   1. Manufacturer: Minimum of 5 years experience in the manufacture of engine-generator systems of types, ratings, and characteristics specified. Shall have authorized service center located within 100 miles of project site.

2. Installer: Minimum of 3 years successful installation experience on projects utilizing equipment similar to that required for this project.
3. Professional Engineer:
    a. Generator enclosure, fuel tank, and access platforms and stairs drawings and calculations shall be prepared and sealed by a professional engineer licensed in the state of Ohio and qualified in the specialty involved.

D. System Responsibility
1. Engine-generator system and accessories furnished by a single supplier.
2. Supplier responsible for the performance of the entire system.
3. Responsibility shall not be split among suppliers of individual components.

E. Testing
1. Prototype Test
    a. Performed on the model/series of engine-generator set to be supplied.
    b. Perform the following tests:
        1) Maximum power output.
        2) Maximum motor starting capability.
        3) Transient response and steady state governing.
        4) Single step load pickup per NFPA 110.
        5) Harmonic analysis and wave form deviation per MIL-STD-705B, Method 601.4.
        6) Three phase short circuit test for mechanical and electrical strength.
        7) Alternator temperature rise test per NEMA MG1.
        8) Fuel consumption.
        9) Engine alternator cooling airflow.
        10) Structural soundness.
        11) Torsiograph analysis per MIL-STD-705B, Method 504.2.
2. Factory Tests
    a. General
        1) Test performed prior to shipment.
        2) Test performed under load with all accessories.
        3) Test measurements made with a light beam oscillograph.
        4) Voltage dip and frequency deviation measured during the fourth complete cycle following application of the load.
        5) Tests performed in accordance with the manufacturer's standards.
    b. Tests Performed
        1) Stepped load test at 1/2, 3/4, and full load for 5 minutes each step.
        2) Three-quarter block load.
        3) Full single step block load.
    c. Test criteria
        1) Maximum 15 percent RMS voltage dip during full single step block load test.
        2) Maximum 15 percent frequency deviation during full single step block load test.
        3) Voltage and frequency recovery to within ±3 percent of rated in less than 5 seconds.
3. Field Test
    a. General
        1) Testing conducted by a representative of the supplier.
        2) Testing to commence after completion of all associated work.

3) Load bank, fuel, and all testing equipment provided by the Contractor.
4) Test to be witnessed by the Owner or the Owner's Representative.
5) Notify the Owner or the Owner's Representative at least one week in advance.
6) Repeat the test until the equipment performs as specified.

b. Cold-Start Test
1) Performed using the generator's actual load as a test load.
2) Simulate power failure by opening the normal power disconnecting means.
3) Record the following information:
a) Time delay on start.
b) Cranking on time.
c) Time required to achieve rated speed.
d) Voltage and frequency dip on application of load.
e) Time to achieve steady state.
f) Voltage, frequency, and amps at standby state.
g) Oil pressure, water temperature, and battery charge rate at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter for 2 hours.
h) Time delay on retransfer after return of normal power.
i) Cool down time delay.

c. Full-Load Test
1) Test to start after cooling time from cold-start test.
2) Perform a one step full load test using a resistive load bank.
3) Perform test with the load bank connected directly to the generator.
4) Record the following information after applying the load:
a) Time required to achieve rated speed.
b) Voltage and frequency dip on application of load.
c) Time to achieve steady state.
d) Voltage, frequency, and amps at standby state.
e) Oil pressure, water temperature, and battery charge rate at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter for 2 hours.

d. Crank Cycle Test
1) Disable generator start by manufacturer approved method.
2) Test the crank cycle by switching the generator to run.

e. Safety Shutdowns: Test all the generator safety shutdowns.

1.4 SUBMITTALS

A. General
1. Comply with the requirements of Division 1 Section "Submittals".
2. Submit information as described below.

B. Product Data
1. Manufacturer's technical product data sheets for all equipment specified in this section.
2. Delete or cross out all inappropriate or non-applicable information.

C. Shop Drawing
1. Dimensional drawings for the engine-generator set and all accessories, including access platforms and anchorages.
2. Mounting details.

D. Wiring Diagrams
   1. Show all components and features specified.
   2. Show all connections to feeders, load, and accessory equipment.
   3. Differentiate between factory and field installed wiring and components.

E. Quality Control Submittals
   1. Submit warranty documents.
   2. Manufacturer's current installation recommendations.
   3. Prototype Test Report
      a. Submit certified performance data and oscillograph plots prior to submitting shop drawings.
      b. If required by the manufacturer, hand deliver confidential data to the Owner's Representative.
      c. After acceptance, the information may be released back to the manufacturer.
   4. Submit factory test report prior to shipment.
   5. Submit certified copies of the field test report.
   6. Operation and Maintenance Manuals
      a. Submit in accordance with Division 01.
      b. Include instructions on storage, installation, start-up, operation and maintenance.
      c. Submit a complete parts list and a recommended spare parts list.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Equipment Storage
   1. Store items furnished under this section until time of installation.
   2. Meet the storage requirements of the manufacturer and supplier.
   3. Do not deliver the stored equipment to the site until it is to be installed.

B. Protection
   1. Use all means necessary to protect the materials and equipment before, during, and after installation
   2. Protect the installed work and materials from the activities of all other trades.

C. Replacements: Immediately repair or replace any damaged equipment.

PART 2 - PRODUCTS

2.1 ENGINE-GENERATOR SET

A. General
   1. UL 2200 rated.
   2. Shall be certified for conformance with Tier 2 non-road emissions regulations.
   3. Provide new equipment, of current manufacture, and free from defects or imperfections affecting performance.
   4. All units of the same type of product shall be from the same manufacturer.
   5. Provide an engine-generator set that is a standard model of the manufacturer.
   6. Design Basis
      a. Design is based on a Kohler engine-generator set.
      b. Any changes to building, ventilation, fuel system, exhaust system, and electrical connections required for proper operation of an engine-generator set shall be the responsibility of the Contractor, without additional cost to the Owner.

7. Sizes, Ratings, and Quantities
    a. Output power: 3000 kilowatts (kW) at 0.8 power factor, minimum.
    b. Output: 6 lead dedicated.
    c. Output voltage: 480Y/277 volt, 3-phase, 4-wire, 60 Hertz at rated speed.
    d. Peak motor starting capacity: 3643kVA @ 15.0% voltage dip.
    e. Steady state frequency regulation: ±0.25 percent.
    f. Maximum frequency dip: 15%.
    g. Altitude rating: 1100 feet above sea level.
    h. Temperature: 104 deg F maximum.
    i. Rated for continuous standby operation.
    j. Single step load pickup: Meet NFPA 110 requirements.

B. Engine and Accessories
1. Engine
    a. Liquid cooled.
    b. Four stroke cycle.
    c. Full compression, diesel for use with No. 2 Ultra low sulfur (ULSD) diesel fuel.
    d. Compression ignited.
    e. Replaceable cylinder liners and not less than 6 cylinders.
    f. Valves shall not require adjustment while in service.
2. Governor: Electronic speed sensing isochronous governor.
3. Starting System
    a. Electric starting motor with starter pinion, 24 volts dc.
    b. Automatically disengage starter after engine starts.
4. Engine Fuel System
    a. Primary and secondary replaceable element fuel filters.
    b. Engine driven, mechanical, positive displacement fuel pump.
    c. Individual, adjustment free injectors for each cylinder.
5. Air Cleaners: Engine mounted, replaceable element, dry type air cleaners.
6. Lubrication System
    a. Positive displacement, mechanical, lubricating oil pump.
    b. Full flow, replaceable element, oil filters.
    c. Liquid cooled oil cooler.
    d. Dipstick oil level indicator.
    e. Spring loaded valve to bypass clogged oil filter.
7. Engine Block Heater: Shall be automatically controlled by an adjustable thermostat, but automatically turn off when the engine is running. Heater shall operate on 208 VAC, single phase.

C. Cooling System
1. Radiator
    a. Engine mounted with pusher type fan.
    b. Duct adapter flange.
2. Coolant: Fill with 50 percent solution of ethylene glycol and water.
3. Coolant Heater
    a. Engine mounted.
    b. Voltage: 208 volt, single phase
    c. Wattage: As required to maintain specified coolant temperature.
    d. Thermostatically controlled.
    e. Oil pressure switch disconnect
    f. Temperature range: 130 deg F to 160 deg F.

D. Alarm Sensing: Provide sensing elements for the following alarms and engine shutdowns:
   1. Low coolant temperature alarm.
   2. Low oil pressure alarm.
   3. Low oil pressure shutdown.
   4. High coolant temperature alarm.
   5. High coolant temperature shutdown.
   6. Over-speed shutdown.
   7. Over-crank lockout.

E. Generator
   1. Construction
      a. Standby duty salient pole, synchronous generator.
      b. Full amortisseur windings.
      c. Drip proof, dual bearing, self-aligning.
      d. NEMA Class F insulation.
      e. Directly connected to the engine through a flexible coupling.
      f. Do not connect the generator neutral to ground at the generator.
   2. Exciter
      a. Brushless rotating exciter with a solid-state full-wave rectifier.
      b. Capacity for 150 percent of required excitation at rated load and voltage.
   3. Voltage Regulator
      a. Solid state.
      b. ±0.5 percent no load to full load regulation during steady state conditions.

F. Engine-Generator Set Controls
   1. General
      a. Control panel mounted on engine-generator set.
      b. Rigid metal enclosure.
      c. Provisions for load cable terminations.
      d. Nameplates to identify each device or function.
   2. Controls
      a. Generator output power thermal-magnetic circuit breaker.
      b. Maintained contact, emergency stop, push button.
      c. Output voltage adjustment potentiometer.
      d. Automatic start-stop cranking controls.
      e. Exercise timer.
      f. Contact for motorized louver, opens when engine begins to crank and closes when engine shuts down.
   3. Indicators
      a. Engine oil pressure.
      b. Coolant temperature.
      c. Engine oil temperature.
      d. Engine hour meter.
      e. Voltmeter, all phase to phase and to ground.
      f. Ammeter, all phases.
      g. Frequency meter.
   4. Alarms
      a. Low engine oil pressure alarm light - red.
      b. Low engine oil pressure shutdown light - red.
      c. High coolant temperature alarm light - red.
      d. High coolant temperature shutdown light - red.

e. Low coolant temperature alarm light - red.
f. Over-crank lockout light - red.
g. Audible alarm and reset button.

G. Base
1. Mount the engine-generator set on a structural steel base.
2. Base shall maintain proper alignment between components during shipment, installation, and operation.
3. The engine-generator set shall be free from torsional stress when running within ±10 percent of rated speed.
4. Vibration Isolators:
a. Provide spring type isolators with rubber backing between base and foundation.
b. Isolators shall provide a minimum of 90 percent isolation.

H. Manufacturers: Subject to compliance with the requirements, provide engine-generator sets manufactured by one of the following:
1. Kohler
2. Caterpillar Tractor Company
3. Cummins/Onan

2.2 ENGINE-GENERATOR SET ACCESSORIES

A. Controller
1. Battery powered.
2. Meeting Level 1 requirements of NFPA 110.
3. Provide the following alarms and controls:
a. Audible alarm and silence button.
b. Lamp test button.
c. Over-crank alarm light.
d. Low coolant temperature alarm light.
e. High coolant temperature pre-alarm light.
f. High coolant temperature shutdown light.
g. Low oil pressure pre-alarm light.
h. Low oil pressure shutdown light.
i. Over-speed light.
j. Low fuel light.
k. Control switch not in auto light.

B. Spare Parts: As recommended by the standby generator system manufacturer.

C. Control power transformer and circuit breaker disconnects inside the generator enclosure for all 120 VAC and 208 VAC circuits on and around the generator system. Install 120 VAC receptacles inside the generator enclosure for the battery charger and maintenance access to the system. One 30A, 208V single phase circuit shall be run to the generator system for all necessary system accessories.

2.3 BATTERY SYSTEM

A. Batteries
1. Lead-acid or AGM.
2. Ampere-hour rating equal to or greater than the manufacturer's recommendations.

3. Capacity for a minimum of three cranking cycles in the ambient temperatures specified.
4. Unit mounted rack for battery mounting.
5. Battery cables of adequate size to prevent voltage drop problems during cranking cycle.
6. Battery heater blanket, 208 volt, to maintain batteries between 50 deg F and 90 deg F.

B. Battery Charger
1. 10 amp, minimum, automatic solid-state battery charger.
2. Float and equalize charge rates.
3. Automatic 24-hour equalizing timer.
4. Automatic line voltage compensation.
5. Output voltage regulation.
6. Capable of fully recharging batteries within 24 hours.
7. Fused input and output.
8. Surge and current limit overload protection.
9. Output ammeter and voltmeter
10. Input voltage on pilot light.
11. Equalize charge light.
12. Alarm relays for connection to the generator annunciator.
    a. Low output voltage
    b. High output voltage.
    c. Current failure.
    d. Input power failure.

C. Manufacturers: Subject to compliance with the requirements, provide equipment manufactured by one of the following:
1. Chloride Incorporated.
2. LaMarche Manufacturing Company.
3. Marathon Battery Company.

2.4 EXHAUST SYSTEM

A. Exhaust Silencer
1. Side inlet.
2. Multi-chambered construction.
3. Critical silencing suitable for residential installation.
4. Sized to assure proper operation without excessive back pressure.

B. Exhaust Piping
1. Minimum 24-inch-long flexible stainless steel connecting pipe
2. Additional exhaust pipe as required.
3. Flanged condensate drain and piping to outside of housing.

C. Manufacturers: Subject to compliance with the requirements, provide equipment manufactured by one of the following:
1. Nelson Industries Incorporated.
2. Riley-Beaird, Inc.
3. York Industrial/Exhaust Silencers.

2.5 SUB-BASE MOUNTED FUEL TANK

A. General

1. UL listed and labeled.
2. Conform to applicable NFPA requirements.
3. Comply with Ohio Fire Code requirements.

B. Construction:
1. Constructed of steel plate of thickness required by applicable standards.
2. Double wall construction.
3. Provide openings for vent, fill, fuel level gauge, supply piping, and return piping.
4. Fabricate tank base to mate with generator base
5. Fabricate tank separately from base and bolt to base after fabrication.
6. Bolt completed tank to the generator skid.
7. Provide a minimum of two inches of air space between that tank and the concrete base.
8. Prime and finish paint complete assembly to match color of engine-generator set.
9. Size tank to hold enough fuel to operate the generator at full load for 24 hours.

C. Accessories
1. Provide vent line to outside with approved cast iron screened rain shield.
2. Leak Detection
   a. Provide an inter-tank leak detector with alarm contact
   b. Provide control panel for local and remote annunciation of leak.
3. Provide fuel level gauge with adjustable low level alarm contacts.

2.6 GENERATOR DISCONNECT SWITCH

A. Provide Molded-case type 100 percent rated with ground fault protection.

2.7 WEATHERPROOF/SOUND ATTENUATING ENCLOSURE

A. General: Completely enclosed weatherproof housing to protect the generator from adverse weather conditions.

B. Design:
1. Structure shall be capable of withstanding controlling effects of gravity and lateral loads following basic and load combination in accordance with Laws and Regulations. Comply with 2017 Ohio Building Code, ASCE 7-10 and referenced standards herein.
2. Site specific snow, wind, and seismic factors are shown on the Drawings.
3. Structure shall be designed to withstand all shipping and erection loads.
4. Generator enclosure is classified as a Risk Category IV per table 1604.5 of the Ohio Building Code for seismic load determination.
5. Seismic Design Category C.

C. Construction
1. Constructed of reinforced sheet steel, primed and painted.
2. Hinged, lockable, removable side panels.
3. Hinged, lockable door over the generator control panel.
4. Louvered vent air openings.
5. Generator silencer mounted inside housing and be designed to limit exhaust noise to below 85 db(A) @ 23 ft. when generator is installed where shown on the Drawings and operating at full load. The seven different locations shall be determined by the Owner.
6. All fasteners shall be stainless steel.

7. Install at least three switch controlled vapor tight incandescent lights inside the enclosure. Light power circuit shall include timer for automatic shut-off.
8. Provide framing, supports, and anchorage to foundation as required to provide access platforms and stairs to all access doors on the enclosure. All framing, grating, and railing shall be aluminum. Anchorage to foundation shall comply with Section 05 0533, Anchor Systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspection
1. Inspect installed work of all other trades prior to performing work of this section.
2. Verify that the project has progressed to a point where this installation may begin.

B. Discrepancies
1. Immediately notify the Engineer in writing if any discrepancies are found.
2. Do not proceed with the installation until all discrepancies have been resolved in a manner acceptable to the Engineer.

3.2 INSTALLATION

A. Engine-Generator Set
1. Provide a concrete pad as shown on the Drawings.
2. Install the generator using the vibration isolators provided with the set.
3. Level the generator set and secure in place as recommended by the manufacturer.

B. Connections
1. Tighten all connections in accordance with manufacturer's published torque values.
2. Where manufacturer's requirements are not indicated, comply with UL Standard 486A.

C. Grounding
1. Do not connect the neutral wire to ground at the generator when using a three-pole transfer switch.
2. Provide a permanent engraved nameplate installed at the location where the generator neutral conductor is connected to a grounding electrode conductor per NEC Article 700-8(b), 701-9(b), or 702-8(a).

D. Spare Parts: Tag all spare parts and store, on the site, as directed by the Owner.

E. Instruction
1. Provide for training by a qualified representative of the manufacturer.
2. Provide a minimum of 1 day of start-up and operation training.
3. Provide a minimum of 1 day of maintenance training.
4. Training will not commence until all required tests have been performed and final approval has been given.

F. Load bank, fuel, and all testing equipment not provided by the generator manufacturer shall be provided by the Contractor. Contractor shall coordinate these requirements with the generator manufacturer.

G. Automatic transfer switch manufacturer's startup technician shall be present during generator startup. Contractor shall coordinate this requirement with both equipment suppliers.

H. Field tests shall be repeated until equipment performs as specified.

I. After startup procedures have been successfully completed and accepted by the Owner, the Contactor shall fill the fuel tank to full capacity.

END OF SECTION 26 3213

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SECTION 26 3600

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install transfer switches in accordance with the plans and as specified herein.

B. Types of transfer switches required for the project include the following:
   1. Automatic transfer switches.

C. Extent of transfer switch work, which includes furnishing and installing control devices, is indicated by drawings and schedules and as specified herein

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all work to furnish and install transfer switches in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and National Electrical Code (NEC) as applicable to construction and installation of electrical power transfer switches.
   2. Underwriters' Laboratories, Inc. (UL) Compliance: Comply with applicable requirements of UL 1008 "Automatic Transfer Switches" and UL 486A "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide transfer switches and components which are UL listed and labeled and rated for short circuit interrupt and withstand ratings indicated.
   3. National Electrical Manufacturers Association (NEMA) Compliance: Comply with applicable requirements of NEMA Standard Pub/Nos. ICS 2 "Industrial Control Devices, Controllers and Assemblies," ICS 6 and 250, pertaining to transfer switches.
   4. National Fire Protection Association (NFPA) Compliance: Comply with applicable requirements of NFPA 101 "Code for Safety to Life from Fire in Buildings and Structures" pertaining to transfer switches.
   5. Comply with applicable requirements of NFPA 110 "Emergency and Standby Power Systems.

B. Qualifications
   1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electrical power transfer switches, of types, ratings, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing electrical power transfer switches similar to that required for this project.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submit the following in accordance with conditions of Contract and Division 01 specification sections:
   1. Product Data: Submit manufacturer's data and installation instructions for electrical power transfer switches.
   2. Shop Drawings: Submit layout drawings of electrical power transfer switches showing accurately scaled equipment locations and spatial relationships to associated electrical equipment in proximity.
   3. Wiring Diagrams: Submit elementary control or ladder wiring diagrams for electrical transfer switches, and associated control devices showing connections to prime and alternate power sources, electrical load, and equipment components. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.
   4. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for short-circuit closing and withstand ratings applicable to units for Project.
   5. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
   6. Maintenance Data: For each type of product to include in the maintenance manuals specified in Division 01. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver transfer switches and associated devices in factory fabricated type containers or wrappings, which properly protect equipment from damage.

B. Handle transfer switches and associated devices carefully to prevent physical damage to equipment. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

C. Store transfer switches and associated devices in original packaging, and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping and only after permission from the A/E.

1.6 SPECIAL WARRANTY

A. General: The transfer switches shall be warranted for a minimum period of 5 years or 1,500 hours, whichever comes first, from the date of final acceptance. Satisfactory warranty documents must be provided. The first year, all travel time, mileage, labor, and parts shall be covered; the second and third years, labor and parts only. The fourth and fifth years, parts only

shall be covered. Such warranty shall be a direct agreement between a specific vendor and the Owner, signed by both the supplier and Owner and delivered via the A/E to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Except as otherwise indicated, provide manufacturer's standard design, materials, and components as indicated by published product information, designed and constructed as recommended by manufacturer for duty indicated, and as required for a complete installation.

B. Automatic Transfer Switches
   1. Sizes, Ratings, and Quantities: Provide [**3-**] [**4-**]pole automatic transfer switches with [**switching neutral**] [**solid neutral**] voltage and ampere ratings as shown on plan. Switch shall have a short circuit current withstand rating of 50,000 amps RMS symmetrical.
   2. General: Provide automatic transfer switches to automatically transfer the facility load to the generator during power outages. The switches shall be electrically operated, mechanically held units with a neutral position and both electrical and mechanical interlocks to prevent simultaneous energizing of both sides. Switches shall have a manual operating handle with transfer speed equal to automatic operation. The manual operating handle shall be dead front and all power cable, contacts, and lugs shall be covered to protect personnel from injury if the switch is closed into a bolted fault condition. Switches shall be capable of switching both inductive and noninductive loads. All terminals and lugs shall be suitable for copper wire.
   3. Enclosure: The transfer switch shall have a NEMA 1 enclosure. Enclosures for switches 1,000 amps and above shall be freestanding. The enclosure shall have a swing-out service panel, a door lock, and a through-the-door manual operator. The enclosure shall be coated with the manufacturer's standard color acrylic enamel finish over a corrosion resistant primer.
   4. Control Section: All controls for each automatic transfer switch shall be located on a swing out dead front panel with clearly labeled functional names. All voltage sensors, relays, and timers shall be plug-in type with retainer clip. All voltage sensors shall be 3 phase. The switch shall have a contact to start the generator on power failure and a normally open auxiliary contact for both sides of the switch. All control and auxiliary contacts shall be wired to terminal blocks. Provide the following control devices mounted in the front of the panel. Switch shall have voltage sensor on each phase for normal and generator.
      a. A green push-to-test normal position light.
      b. An amber push-to-test neutral position light.
      c. A red push-to-test standby (emergency) position light.
      d. A key operated test/normal selector switch.
      e. A load/no load test selector switch.
      f. A manual/auto selection switch to disable (manual) or enable (auto) power to the electric operator.
   5. Operation Sequence
      a. The switch shall signal the generator to start (adjustable 0 to 3 second time delay) when normal supply voltage falls to less than 70 percent of nominal.
      b. The switch shall transfer the load to the generator after the generator reaches rated voltage and frequency (adjustable 0 to 7 second time delays).
      c. The switch shall transfer the load back to the normal source after return of normal voltage to 90 percent of nominal voltage (adjustable 0 to 30 minute time delay).

d. The switch shall stop in the neutral position for each transfer direction (Range: adjustable 0.5 to 5 seconds.)
e. The switch shall signal the generator to stop after cool down time following transfer back to the normal source (adjustable 1 to 5 minute time delay).
f. The switch shall bypass the time delay and transfer the load back to the normal source if the generator output fails after return of normal power.

6. Accessories
   a. Provide transfer switches with auxiliary control relays which energize when the transfer switch is in the "standby power" position and the generator is running. Relay shall de-energize upon transfer to normal power. Provide six normally closed and two normally open contacts for each relay. One NC contact shall be utilized by each group of elevators. See Division 26 Section “Control Devices”, for relay requirements.
   b. Provide a test and retransfer timing circuit in each transfer switch feeding elevator loads. The circuit shall have a contact for each group of elevators. The contact shall close 20 seconds prior to transferring back from standby to normal power, and open upon transfer completion.
7. Engine Shutdown Contacts: Time delay adjustable from 0 to 5 minutes; factory set at 5 minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.
8. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory-set periods are for 7 days, 20 minutes, and 5 minutes, respectively. Exerciser features include the following:
   a. Exerciser Transfer Selector Switch: Permits selection between exercise with and without load transfer.
   b. Push-button programming control with digital display of settings.
   c. Integral battery operation of time switch when normal control power is not available.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide transfer switches of one of the following:
   1. Automatic Transfer Switches
      a. Eaton Corporation
      b. Square D Company
      c. Kohler
      d. Lake Shore Electric Corporation
      e. Russelectric Inc.
      f. Cummins Bridgeway.
      g. ASCO.
      h. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas and conditions under which transfer switches are to be installed and notify the A/E in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the A/E.

B. Install transfer switches, including associated control devices as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that transfer switches comply with requirements. Comply with applicable requirements of NEC and NFPA pertaining to wiring practices and installation of electrical power transfer switches.

C. Provide and install housekeeping pads for all floor mounted transfer switches.

D. All power wiring shall be lashed and anchored to withstand short circuit currents.

E. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of transfer switch work with other work.

F. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

3.2 GROUNDING

A. Provide equipment grounding connections for transfer switch units as indicated. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.3 FIELD QUALITY CONTROL

A. Test transfer switches, by means of simulated power outage; automatic start-up by remote automatic starting, transfer of load and automatic shutdown. Prior to these tests, adjust transfer switch timers for proper system coordination.

B. Automatic transfer switch manufacturer’s startup technician shall be present during generator startup. Contractor shall coordinate this requirement with both equipment suppliers.

C. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of transfer switches with requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting, where necessary, shall be at no cost to Owner.

3.4 PERSONNEL TRAINING

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting up, testing, and operating transfer switches and auxiliary equipment.

END OF SECTION 26 3600

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SECTION 26 4100

LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and material necessary to install a lightning protection system in accordance with the Plans and as specified herein.

B. Work of this Section includes, but is not limited to:
   1. Lightning protection system.

1.3 QUALITY ASSURANCE

A. General
   1. Provide a complete lightning protection system including all items required for protection against damage by lightning.
   2. Provide a lightning protection system to cover all areas designated on the Drawings.

B. Codes and Standards
   1. The lightning protection system shall comply with the provisions of the latest "Lightning Protection Code" as adopted by the National Fire Protection Association and Underwriters' Laboratories, Inc.
   2. Underwriters' Laboratories Master Label shall be furnished as evidence that the installation has met with U.L. requirements. The installer shall have the Owner sign an application for a UL "Master Label". The 4 inch by 2-1/2 inch brass "Master Label" plate shall be received by the Owner in the mail directly from UL through the Manufacturer of the equipment.

C. Installers Qualifications: The Installer of Work of this Section shall be a firm regularly engaged in this kind of work for the past 5 years and a member of the Lightning Protection Institute.

1.4 DEFINITIONS

A. Air Terminal: Pointed solid rods provided with a proper conductor connection and mounting bracket.

B. Bonding: A connection between a metal object and an element of a lightning protection system to accomplish electrical continuity between the two.

C. Cable: A conductor formed of a number of wires stranded together.

D. Class II Materials: All conductors, fittings and fixtures necessary to protect ordinary buildings and structures exceeding 75 feet in height.

E. Conductors: The portion of a lightning protection system designed to carry the lightning discharge between air terminals and ground.
   1. Main conductors interconnect air terminals and serve as downleads to ground.
   2. Secondary conductors are used to accomplish various bonding and other connections.

F. Copper-clad Steel: Steel with a coating of copper bonded to it. Copperweld.

G. Fastener: An attachment to secure the conductor to the structure.

H. Ground Terminal: That portion of a lightning protection system extending into the earth, such as a ground rod, ground plate or the conductor itself, serving to bring the system into electrical contact with the earth.

I. Labeled: Equipment or materials with an attached label or identifying mark indicating the organization concerned with product evaluation and periodic evaluation of listed equipment and materials used in the lightning protection system.

J. Metal Clad Building: A building or structure with either sides or roof made of or covered with sheet metal.

K. Metal Framed Building: A building with electrically continuous framing of sufficient size and conductivity to be utilized as part of the lightning protection system.

L. Zone of Protection: The zone of protection provided by a grounded air terminal or mast is that adjacent space which is substantially immune to direct strokes of lightning.

1.5 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.
   1. Product data for each component. Include electrical ratings, dimensions, mounting position, mounting method, vertical supports, materials, fire stops, and weather stops.
   2. Shop drawings detailing fabrication and installation of busways, including plans, elevations, sections, details of components, and attachments to other construction elements. Detail connections to switchgear, switchboards, and transformers. Detail supports and connections to building.
   3. Design data indicating zone of protection, showing elevations and plans and other factors that influence location of air terminals and down leads.

B. Reference Submittals
   1. Special Guarantees and Warrantees.
   2. Installers Certification.
   3. Material Certification.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM

A. General

1. All materials shall comply in weight, size and composition with the requirements of the Underwriters' Laboratories, Inc., the National Fire Protection Association Code and OSHA relating to the height of the structure.
2. All rods, cables, ground rods, and connectors used in the system shall carry an UL Label "A" & "B" and all lightning air terminals shall carry the Manufacturer's name.

B. Air terminals: Standard 12 inch Government point air terminals, solid copper bronze, nickel plated, with 5/8 inch inside thread with appropriate bronze base mounting bracket and cable clamps.

C. Conductors: Conductors shall consist of commercially pure copper cable, sized in accordance with NFPA Code.

D. Conductor Fasteners: Conductor fasteners shall be an approved type of noncorrosive metal having ample strength to support conductor.

E. Ground Connection: Ground connection shall be of 3/4-inch x 20’- 0" "Copperweld" rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. All ungrounded sizable metallic objects within 6 feet of the system or metal connected to the system shall be bonded to the system with approved fittings and conductor.
2. Copper materials connecting to steel shall be lead-coated.
3. Connection between other dissimilar metals shall be made with approved bimetallic connectors.
4. Bonding of all metal Work and ventilators on roof shall be included in the above.
5. Where conductors or air terminals pass through roof, they shall be properly flashed to conform with the roofing requirements.
6. All materials shall be fastened to eliminate any possibility of displacement and subsequent maintenance.
7. Anchor bolts shall be stainless steel expansion type anchor bolts for anchoring to concrete and masonry surfaces.
8. All bolts, nuts and washers furnished with the accessories of the system shall be of a noncorrosive metal compatible with the metals of the accessory and fabricated for the accessory.
9. Clamps, connectors, support brackets and other miscellaneous accessories shall be as recommended by the protection system manufacturer.
10. Secure all points to structure by approved methods. Lightning protection system shall be adhered directly to the roof surface with the adhesive recommended by roofing supplier. Coordinate methods with roofing contractor and provide all wear pads, stripping, battens, heat weld strips or pavers in order to maintain roof warranty.

B. Air Terminals
1. The required number of air terminals shall be provided on parapet walls, perimeter, smoke stacks, chimneys, television antennas, penthouses, etc.
2. Air terminals shall be approved type extending not less than 10 inches above the roof and shall have proper base support for surface on which used and shall be securely anchored to this surface.

3. Air terminals shall not extend higher than 24 inches except with individual approval or as required by OSHA. Terminals 23 inches and less shall be spaced 20 feet apart.
4. Terminals 24 inches and higher shall be spaced 25 feet apart or as required by codes.

C. Conductors:
1. The main conductor routing shall primarily be around and on top of the parapet walls.
2. The down conductors (main conductors down the faces of the structures to the ground rods) shall be surface mounted on the exterior faces of the structures in protected locations (beside pilasters, down spouts or exposed pipes) where possible or otherwise in locations least subject to ground level damage.

D. Conductor Fasteners: Space 3'-0" O.C. max.

E. Ground Connection
1. Drive to the required depth to reach permanent moisture but in no case less than 11'-6". In case of rock ledge or other conditions making compliance impossible, trench or other grounding will be permitted, providing it will pass UL requirements.
2. A minimum of two grounds shall have connection to the water system and structural steel framing of the building.

END OF SECTION 26 4100

SECTION 26 4300

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Summary: These specifications describe the electrical and mechanical requirements for a modular, high-energy surge protective devices (SPDs) to be located where shown on the drawings.

B. Related Sections include the following:
   1. Division 26 Section “Wiring Devices”.
   2. Division 26 Section “Switchboards”.
   3. Division 26 Section “Panelboards”.
   4. Division 26 Section “Motor Control Centers”.

C. Standards: The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. Underwriters Laboratories; UL 1449 3rd Edition 2009 Revision (effective 9/29/2009)
   2. Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.34, C62.41, C62.45)
   3. Institute of Electrical and Electronic Engineers 1100 Emerald Book
   4. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
   5. National Fire Protection Association (NFPA 20, 70, 75 and 780)

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Manufacturers shall submit independent test data from a nationally recognized testing laboratory verifying the following: life cycle testing, overcurrent protection, UL1449 3rd Edition, noise attenuation and surge current capacity. Failure to do so will result in product disapproval.

B. Equipment Manual: The manufacturer shall furnish an installation manual with installation, startup, and operating instructions for the specified system.

C. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer that show unit dimensions, weights, component and connection locations, mounting provisions, connection details and wiring diagram.

1.4 QUALITY ASSURANCE

A. Codes: Perform all work in compliance with NFPA 70, National Electrical Code (NEC) and all applicable federal, state, and local codes and regulatory requirements.

B. Manufacturer: The specified interconnect assembly shall be designed and manufactured in the USA by a qualified manufacturer of SPD products. The manufacturer shall have at least 5 years experience in the design, testing, and manufacturing of surge protective devices.

C. Installer: Minimum of 3 years successful installation experience on projects utilizing equipment similar to that required for this project.

D. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 PROJECT CONDITIONS

A. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
   1. Operating Frequency: 50 or 60 Hz.
   2. Operating Temperature: -40 to 140 deg F.
   3. Humidity: 0 to 95 percent, non-condensing.
   4. Operating Altitude: 0 to 18,000 feet above sea level.

B. Warranty: The manufacturer shall provide a (5) (10)-year full parts replacement warranty

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
   1. Liebert Corp.
   2. Thor Systems, Inc.
   3. Phoenix Contact.
   4. Current Technology.
   5. DEHN.
   6. Protection Technology.

B. The SPD terminals shall accommodate the wire sizes as shown on the drawings.

2.2 REQUIREMENTS

A. Performance Ratings:
   1. Surge Current Capacity – Service Entrance and main distribution panels shall be UL Listed Type 1 SPD with a 200 kA Surge Rating per Mode.

2. Surge Current Capacity –Branch panels shall be UL Listed Type 2 SPDs with a 100 kA Surge Rating per Mode.
3. UL 1449 Nominal Discharge Current: The UL 1449 Nominal Discharge Current Rating shall be 20kA.
4. Protection Modes: The SPD shall provide protection in all modes: L-N or L-L, L-G and N-G (where applicable). Note: L = Line, G = Ground, N = Neutral
5. UL 1449 Voltage Protection Ratings: The maximum UL 1449 listed surge ratings for each and/or all of the specified protection modes shall not exceed the following:

System Voltage	UL 1449 Second Edition SVR				UL 1449 3rd Edition VPR			
	L-N	N-G	L-G	L-L	L-N	N-G	L-G	L-L
120/240	400V	400 v	400 v	800 v	800 v	700 v	900 v	1200 v
120/208	400 v	400 v	400 v	800 v	800 v	700 v	900 v	1200 v
240			800 v	800 v			1200 v	2000 v
277/480	700 v	700 v	700 v	1500 v	1200 v	1200 v	1200 v	2000 v
480			1500 v	1500 v			2000 v	2000 v

B. Life Cycle Testing: The SPD shall be life cycle tested to withstand 10kA (8x20µs), 20kV (1.2x50µs), IEEE C62.41 Category C surge current with less than 5% degradation of clamping voltage. The service entrance and main distribution panel SPDs shall withstand a minimum of 15,000 Category C 10kA Surges per Mode. Branch panel SPDs shall withstand a minimum of 6,000 Category C 10kA Surges per mode.

C. Overcurrent Protection: Fusing: All surge suppression components shall be individually fused and rated to allow maximum specified surge current capacity with an interrupting rating greater than the available short circuit current. Devices that utilize a single fuse to protect two or more suppression paths are not excepted. Replaceable fusing is unacceptable. Overcurrent protection that limits specified surge currents is not acceptable. Where the avialable short circuit current is not shown, the fusing shall be rated for 200kAIC.

2.3 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. One set of Form C contacts, for remote monitoring of protection status.
9. Surge-event operations counter.
10. NEMA 4X Enclosure.

2.4 PANELBOARD SUPPRESSORS

A. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.

4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of Form C contacts for remote monitoring of protection status. Coordinate with building management system.
10. Surge-event operations counter.
11. NEMA 4X Enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. The installing contractor shall install the SPD with as short of conductors as practically possible and twist the SPD input conductors together to reduce conductor inductance. The contractor shall follow the SPD manufacturer's recommended installation practices as found in the installation, operation and maintenance manual and comply with all applicable codes. Type 2 SPDs shall be connected to circuit breakers or fuses as required by the SPD's UL Listing.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/486B.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
   2. Complete startup checks according to manufacturer's written instructions.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION 26 4300

SECTION 26 5000

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to work of this Section.

B. Division 26, Section “Basic Electrical Materials and Methods” applies to work specified in this section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install lighting fixtures in accordance with the plans and as specified herein.

B. Types of lighting fixtures in this section include the following:
1. Fluorescent.
2. HID.
3. Incandescent.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform all to work furnish and install lighting fixtures in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and National Electrical Code (NEC) as applicable to installation and construction of lighting fixtures.
2. National Electrical Manufacturers Association (NEMA) Compliance: Comply with applicable requirements of NEMA Standard Publication Nos. LE 1 and LE 2 pertaining to lighting equipment.
3. Underwriters' Laboratories, Inc. (UL) Compliance: Comply with UL standards, including UL 486A and B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL listed and labeled.
4. Certified Ballast Manufacturers (CBM) Labels: Provide fluorescent lamp ballasts which comply with CBM Association standards and carry the CBM label.
5. National Fire Protection Association (NFPA) Compliance: Comply with applicable requirements of NFPA 780, "Lightning Protection Code," pertaining to installation of exterior lighting fixtures.
6. Special Listing and Labeling: For use in damp or wet locations, and combustible construction, provide fixtures specifically listed and labeled for such use.

B. Qualifications
1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting fixtures of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with lighting fixture work similar to that required for this project.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data, test reports, and materials certifications as required.

B. Submit the following in accordance with Conditions of Contract and Division 01 specification sections:
   1. Product Data: Submit manufacturer's product data and installation instructions on each type lighting fixture and component including lamp data.
   2. Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet. Clearly indicate all accessories and quantities. Provide dimensioned layout drawings, showing dimensional relationship to structure, for continuous row type fixtures.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver lighting fixtures in factory fabricated containers or wrappings, which properly protect fixtures from damage.

B. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

C. Store lighting fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of lighting fixtures with other work.

B. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not limited to, housings, energy efficient lamps, lamp holders, reflectors, energy efficient ballasts, starters, and wiring. Ship fixtures factory assembled, with those components required for a complete installation.
   1. All lighting fixtures shall be in accordance with the Fixture Schedule.
      a. The fixture schedule provides the Manufacturer's fixture catalog series.
      b. The fixture provided shall conform to the description in fixture schedule, the Manufacturer's catalog number, and all provisions of the contract documents.

2. All fluorescent fixtures shall have a code gauge steel housing having a white baked enamel or polyester powder coated finish which shall have a minimum reflectance of 87%, unless otherwise noted.
3. All fluorescent fixtures noted to have 0.125 inch thick pattern 12 lens shall have a maximum prism penetration in the lens of 0.080 inches and shall have a minimum lens weight of 8 ounces per square foot.
4. The Contractor shall provide the fluorescent fixture with the mounting method required for the ceiling system set forth on the architectural Drawings, (such as, the reflected ceiling plans, and room finish schedule) and in Division 09 of the project manual.
5. All surface mounted fluorescent fixtures to be furnished and installed on low density ceilings shall be UL listed for that application.
6. The actual aperture dimension of all incandescent and fluorescent fixtures provided shall be plus or minus 1/2 inch on the nominal value indicated.

2.2 WIRING

A. Provide electrical wiring within fixture as required for UL listing suitable for connecting to branch circuit wiring.

B. Refer to applicable Division 26 sections.

2.3 BALLASTS

A. General: Ballasts shall not have PCB type ballast fill or compound or PCB type capacitors.

B. Fluorescent Ballast
1. All fluorescent fixtures shall have solid state electronic ballasts. Ballasts shall meet the provisions of FCC part 18 for EMI/RFI limits and shall withstand transients as specified by IEEE Publication 587, Category A, ANSI C62.41, Category A.
2. Ballasts shall be UL listed, Class P, sound rated A.
3. Ballasts shall meet the following electrical characteristics:
   a. Input voltage: 277 volt, unless otherwise noted.
   b. Minimum power factor of 0.95.
   c. Maximum total harmonic distortion (THD) of 15%.
   d. Lamp current crest factor of 1.5 or less.
   e. Minimum ballast factor of 0.87.

C. HID Ballasts
1. HID ballasts shall conform to UL 1029 and ANSI C82.4.
2. Provide HID ballasts with the following features:
   a. Constant Wattage Autotransformer (CWA) or regulating high power factor type, unless otherwise indicated.
   b. Operating Voltage: Refer to fixture schedule on plans.
   c. Minimum Starting Temperature: -30 deg C.
   d. Rated Ambient Operating Temperature: 40 deg C.
   e. Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at 90 deg C.

2.4 LAMPS

A. Incandescent Lamps: 125 V, inside frosted type except where otherwise noted.

B. Fluorescent Lamps
   1. T8 Rapid Start: T8 rapid start lamps shall be 32 watt and rated 2900 lumens minimum. Lamps shall have a color temperature of 3500 deg K and a minimum color rendering index (CRI) of 70.
   2. Compact Fluorescent
      a. Compact lamps shall be wattage and type as indicated on the fixture schedule.
      b. Biax lamps used in 2-foot x 2-foot fixtures shall have a color temperature of 3500 deg K and a minimum CRI of 80.
      c. Lamps used in downlights shall have a color temperature of 2700 deg K and a minimum CRI of 82.

C. HID Lamps
   1. Provide HID lamps in types and wattage as indicated on the lighting fixture schedule on plans.
   2. HID lamps shall be by the same manufacturer, provide high color-rendering, and high efficiency.
   3. Lamp bases shall mate and match lamp socket configuration.

2.5 EXTRA MATERIALS

A. General: Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Owner.

B. Lamps: Provide a quantity equal to 10 percent of installed units but no fewer than six of each type.

C. Diffusers and Lenses: Furnish 2 of each type.

D. Ballasts: Furnish 2 of each type.

2.6 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   1. Fixtures
      a. As indicated on the fixture schedule.
      b. Or equivalent.
   2. Lamps
      a. GE Lighting.
      b. Osram Sylvania.
      c. Philips Lighting Co.
      d. Or approved equal.
   3. Ballasts
      a. Advance Transformer Co.
      b. GE Lighting.
      c. MagneTek, Inc.
      d. Motorola Lighting Inc.
      e. Valmont Electric.
      f. Prescolite.
      g. Robertson.

h. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Examine areas and conditions under which lighting fixtures are to be installed. Examine substrate/substrata for supporting lighting fixtures. Notify the Owner in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner.

B. Installation
1. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, National Electrical Contractors Association's (NECA) "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
2. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by the A/E.
3. Support fixtures in/on lay-in type grid ceilings by hangers or wire anchors from the structural ceiling, not from the lay-in grid.
    a. Exception: For recessed cans the cans shall be equipped with bar hangers with integral slots for mounting directly to the T-BAR Grid. In addition, all four corners of the T-BAR Grid shall be supported from the structural ceiling by hangers or wire anchors.
4. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.
5. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the NEC.
6. Structurally support surface-mounted fixtures greater than 2 feet in length at a point in addition to the outlet box fixtures stud.
7. Box-mounted fixtures shall be mounted directly to the mounting ears of the outlet box.
8. Connections to each recessed fixture shall be made with 1/2 inch minimum flexible conduit more than 4 feet and less than 6 feet in length from fixture to outlet box.
9. All splices shall be carefully placed in outlet boxes or wiring gutters with no crowding.
10. Plaster frames shall be supplied by the Contractor where necessary.
11. No circuit other than the one feeding the fixture shall be pulled through a fluorescent fixture.

3.2 GROUNDING

A. Provide ground to all lighting fixtures. Provide equipment grounding connections for exterior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

3.3 ADJUSTING AND CLEANING

A. Aim adjustable lighting fixtures and lamps. Verify aiming requirements as indicated in the lighting fixture schedule.

B. Clean lighting fixtures of dirt and debris upon completion of installation.

C. Protect installed fixtures from damage during construction period.

3.4 FIELD QUALITY CONTROL

A. Replacement: At Date of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Owner.
   1. Refer to Division 01 sections for the replacement/restoration of lamps in lighting fixtures, where used for temporary lighting prior to Date of Substantial Completion.

3.5 DEMONSTRATION

A. Upon completion of installation of lighting fixtures, and associated electrical supply circuitry, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Give the Owner advance notice of dates and times for all field tests.

END OF SECTION 26 5000

SECTION 28 3100

FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of Contract, including General and Supplementary Conditions and all divisions of specification sections, apply to work of this Section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish and install a complete fire alarm systems in accordance with the plans and as specified herein.

B. Work of this Section includes, but is not limited to, the following:
   1. Manual stations.
   2. Smoke detectors.
   3. Heat detectors.
   4. Duct detectors.
   5. Horns/speakers.
   6. Visual alarm signals.
   7. Control/monitor address modules.
   8. Magnetic door holders.
   9. Silent alarm pushbuttons.
   10. Remote annunciator panels.
   11. Remote device location indicating lights.
   12. Fire alarm control panel (FACP).
   13. Emergency power supplies.
   14. Printers.

C. System Description
   1. General: Zoned, noncoded, addressable, microprocessor-based system with automatic alarm initiation, analog addressable smoke detectors, and automatic alarm verification for alarms initiated by smoke detectors.
   2. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.
   3. Audible Alarm Indicators: By voice alarm messages and tone signals on horns and ceiling speakers.
   4. Visual Alarm Indication: By xenon-strobe-type units.
   5. Systems Connections for Alarm-Indicating and Alarm-Initiating Circuits: Class B wiring.

1.3 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage an experienced factory-authorized installer to perform work of this Section.
   2. Submit the names and locations of at least two installations where the Contractor or the subcontractor has installed such systems.

3. The Contractor shall indicate the type and design of these systems and certify that these systems have performed satisfactorily for at least 18 months.

B. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.

C. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.

D. Comply with NFPA 70 and NFPA 72.

E. Comply with the "Americans with Disabilities Act" (ADA).

F. Listing and Labeling: Provide fire alarm systems and components specified in this Section that are listed and labeled by Underwriters' Laboratories, Inc. (UL).
1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

G. Factory Mutual (FM) Compliance: Provide fire alarm system and components that are FM approved.

1.4 SUBMITTALS

A. General: Submittals required by this Section shall be made according to the Conditions of the Contract and Division 01 Specification Sections.

B. Submit product data for each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features and devices. Include list of materials and NRTL-listing data.

C. Submit Shop Drawings showing detailed drawings of control panel(s), command centers, expander panels, multiplexers, fire fighter telephone cabinets and remote annunciator panels.

D. Submit wiring diagrams from manufacturer differentiating clearly between factory and field-installed wiring. Include diagrams for each component of the system with all terminals and interconnections identified. Make all diagrams specific to this Project.

E. Submit floor plans that indicate device locations, interconnecting wiring, and routings of raceways.

F. Submit a device address list to coordinate the final system programming.

G. Submit a system operation description covering this specific Project, including method of operation and supervision of each type of circuit and sequence of operations for all manual and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are unacceptable.

H. Submit calculations for battery capacity for both alarm and supervisory modes.

I. Submit voltage drop calculations for each indicating circuit.

J. Submit product certificates signed by the manufacturer of fire alarm system components certifying that their products comply with specified requirements.

K. Submit agenda for training class and copies of all handouts for the class.

L. Maintenance data for fire alarm systems shall be included in the operation and maintenance manual specified in Division 01. Include data for each type of product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

M. Record of field tests of the fire alarm system shall be included in the operation and maintenance manuals.

N. Submission to Authorities Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the Authorities Having Jurisdiction (AHJ). Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Upon receipt of comments from the authorities having jurisdiction, submit them for review. Resubmit if required to make clarifications or revisions to obtain approval.
   1. Certification: The fire alarm system supplier shall provide the AHJ with shop drawings and a certificate indicating that the system is designed and installed in compliance with the binding State code, and the appropriate acceptance tests have been conducted and approved. Shop drawings shall be sealed and signed by a certified Fire Alarm System Designer, registered in the State where the system will be installed.
   2. Submit evidence that the fire alarm system supplier and the certified Fire Alarm System Designer have reviewed the approved shop drawings for all HVAC and fire alarm systems required on the project. This review shall ensure that all required components to interface these systems to the fire alarm system have been checked for compatibility and are shown on the shop drawings submitted herein.

1.5 JOB CONDITIONS

A. Examine areas and conditions under which fire alarm system components are to be installed, and substrate which will support equipment. Notify Engineer in writing of conditions detrimental to proper completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Deliver fire alarm system components in factory fabricated containers or wrappings, which properly protect products from damage.

B. Handle fire alarm system components carefully to prevent breakage, denting and scoring finish. Wrap finished cabinets individually, in heavy containers for protection in transit. Do not install damaged units or components; replace with new.

C. Store fire alarm system components in original cartons in well ventilated space protected from moisture, construction traffic and debris.

1.7 WARRANTY

A. Manufacturer's Warranty
   1. Period: 1 year
   2. The Manufacturer shall warrant to repair or replace, without cost or undue hardship to the Owner, all of the Manufacturer's Work that is found to be defective, that is not in accordance with the Contract Documents, that fails to performs as represented by the Manufacturer's published product information, or that does not meet generally recognized standards of quality or performance for such Work, whichever is greater. Such warranty shall include the removal and replacement, without cost or undue hardship to the Owner, all other Work which is damaged as a result of removal or replacement of the Manufacturer's Work which is defective or nonconforming or nonperforming, as set forth above. Any labor or parts required during warranty shall be at no charge to the Owner.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of fire alarm system work with other work.

B. Sequence fire alarm installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

1.9 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months following the Manufacturer's warranty using factory authorized service representatives.
   1. Basic Services: Systematic, routine maintenance visits on a biannual basis at times coordinated with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
   2. Additional Services: Perform services within the above 12 month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
   3. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional 1 year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Siemens Fire Safety.
   2. Simplex/Grinnell.
   3. Notifier by Honeywell.
   4. Thorn Security by Tyco International.
   5. GE Fire & Life Safety.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Include the following system functions and operating features plus those additional functions and features required by the authorities having jurisdiction:
   1. Priority of Signals: Accomplish automatic response functions by the first zone initiated. Alarm functions resulting from initiation by the first zone shall not be altered by subsequent alarms. The highest priority shall be an alarm signal. Supervisory and trouble signals shall have second- and third-level priority. Higher-priority signals shall take precedence over signals of lower priority, even though the lower-priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.
   2. Non-interfering: Zone, power, wire, and supervise the system so a signal on one zone does not prevent the receipt of signals from any other zone. All zones shall be manually resettable from the FACP after the initiating device or devices are restored to normal. Systems that require batteries or battery back-up for the programming function are unacceptable.
   3. Fire Alarm Control Panel (FACP) Response: The manual or automatic operation of an alarm-initiating or supervisory-operating device shall cause the FACP to transmit an appropriate signal including the following:
      a. General alarm.
      b. Fire-suppression system operation alarm.
      c. Smoke or heat detector alarm.
      d. Valve tamper supervisory.
      e. Fire pump power supervisory.
      f. Elevator recall.
      g. Elevator shutdown.
      h. System trouble.
      i. Fan shutdown.
   4. Silencing at the FACP: Switches shall provide capability for acknowledgment of alarm, supervisory, trouble, and other specified signals at the FACP; and capability to silence the local audible signal and light a light-emitting diode (LED). Subsequent zone alarms shall cause the audible signal to sound again until silenced by switch operation. Restoring alarm, supervisory, and trouble conditions to normal shall extinguish the associated LED and cause the audible signal to sound again until restoration is acknowledged by switch operation.
   5. Loss of primary power at any fire alarm panel (FACP, FAXP, FMUX, FFTC, etc.) shall sound a trouble signal at the FACP and each annunciator. An "emergency power" light shall illuminate at all panel locations when the system is operating on an alternate power supply.
   6. Annunciation: Manual and automatic operation of alarm and supervisory initiating devices shall be annunciated on the FACP and on each remote annunciator, indicating location and type of device.
   7. FACP Alphanumeric Display: Shall display plain-English-language descriptions and addresses of initiating devices, alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
   8. General Alarm: The fire alarm system general alarm shall include the following:
      a. Indicate the general alarm condition at the FACP and each annunciator.
      b. Identify the device that is the source of the alarm (or its zone) at the FACP and each annunciator.
      c. Initiate audible and visible alarm signals throughout the building.
      d. Release specific door security electric latches and magnetic door locks via the door security system control panels.
      e. Stopping supply and return fans serving zone where alarm is initiated.
      f. Closing smoke dampers on system serving zone where alarm is initiated.

g. Record the event on the system printer.
h. Provide 120VAC Form C contact output at Fire Alarm Control Panel to annunciate a General Alarm condition.

9. Manual station alarm operation shall initiate a general alarm.
10. Water-flow alarm switch operation shall cause the following:
    a. Initiate a general alarm.
    b. Activate the location-indicating light causing it to flash for the device that has operated.
    c. Print a record of the event on the system printer.
11. Smoke detection activation shall cause the following:
    a. Audible and visible indication of an "alarm verification" signal at the FACP.
    b. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
    c. Closure of associated smoke dampers for specific smoke detectors indicated should alarm be verified.
    d. Upon activation of a smoke detector in the elevator lobby, shaft, or equipment room, initiate a signal to capture the elevators. Also provide alternate floor capture signal to re-direct the elevators to a secondary level should the detector at the primary floor level be an alarm.
        1) Verify assignment of primary and alternate floor with local Fire Marshall prior to programming system.
    e. Record the event on the system printer.
    f. Initiate a general alarm if the alarm is verified.
    g. FACP indication cancellation and system reset if the alarm is not verified.
12. Duct smoke detection activation shall cause the following:
    a. Audible and visible indication of an "alarm verification" signal at the FACP.
    b. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
    c. Shut-down of associated air handler/VAV fan motor should alarm be verified.
    d. Record the event on the system printer.
    e. Initiate a general alarm if the alarm is verified.
    f. FACP indication cancellation and system reset if the alarm is not verified.
13. Sprinkler valve tamper switch operation shall cause the following:
    a. A supervisory, audible, and visible "valve tamper" signal indication at the FACP and each annunciator.
    b. Activate the location-indicating light causing it to flash for the device that has operated.
    c. Print a record of the event on the system printer.
14. Fire pump running, power failure, phase-reversal, supervisory power available, and alarm silence condition, shall cause the following:
    a. A supervisory, audible, and visible indication at the FACP and each annunciator.
    b. Print a record of the event on the system printer.
15. Low-air-pressure switch operation on a dry pipe or preaction sprinkler system shall cause the following:
    a. A supervisory, audible, and visible indication at the FACP and each annunciator.
    b. Print a record of the event on the system printer.
16. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP shall cause the selection of specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control changes in those settings. The same controls shall be capable to program repetitive, scheduled, automated changes in

sensitivity of specific detectors. Sensitivity adjustments and sensitivity adjustment schedule changes shall be recorded on the system printer.

B. Recording of Events: The system printer shall print a record of all alarm, supervisory, and trouble events. Printouts shall be by zone, device, and function. When the FACP receives a signal, the alarm, supervisory, and trouble conditions shall be printed. The printouts shall include the type of signal (alarm, supervisory, or trouble) the zone identification, date, and the time of the occurrence. The printouts shall differentiate alarm signals from all other printed indications. When the system is reset, this event shall also be printed, including the same information for device, location, date, and time. A command shall initiate the printout of a list of existing alarm, supervisory, and trouble conditions in the system.

C. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire-detection system alarm-initiating device and its indication at the FACP shall be 3 seconds.

D. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP utilizing a distinctive indicating audible tone and LED-indicating light. The maximum permissible elapsed time between the occurrence of the trouble condition and its indication at the FACP shall be 200 seconds.

2.3 ADDRESSABLE DEVICES

A. Alarm-Initiating Devices: Classified as addressable devices according to NFPA 72.
   1. Communication Transmitter and Receiver: The communication transmitter and receiver shall be integral to the device, providing each device with a unique identification capable of status reporting to the FACP.
   2. External Addressable Interface Unit: External units shall be used where specified devices are not manufactured and labeled with integral multiplex transmitter and receiver. Program to monitor status of each device individually.

2.4 ADDRESSABLE MANUAL PULL STATIONS

A. Description: Double-action type, fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color.
   1. Break-Glass Feature: Stations requiring the breaking of a glass panel are unacceptable. Stations requiring the breaking of a concealed glass rod are acceptable.
   2. Station Reset: Key operated, double pole, double throw, switch rated for the voltage and current at which it operates. Stations shall have screw terminals for connections.

2.5 ADDRESSABLE SMOKE DETECTORS

A. General: Comply with UL 268. Include the following features:
   1. Factory Nameplate: Serial number and type identification.
   2. Operating Voltage: 24-V dc, nominal.
   3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
   4. Plug-in Arrangement: Detector and associated encapsulated electronic components shall be mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection shall not require springs for secure mounting and contact maintenance. Terminals in the fixed base shall accept building wiring.

5. Integral Visual Indicating Light: Indicates detector has operated.
6. Remote Controllability: Individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable at the FACP for sensitivity.

B. Photoelectric Smoke Detectors: Include the following features:
1. Detector Sensitivity: Between smoke obscuration when tested according to UL 268.
2. Sensor: Infrared detector light source with matching silicon-cell receiver.

C. Duct Smoke Detector: Include the following features:
1. Detector: Photoelectric type with adjustable sensitivity.
2. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied.
3. Fan Shutdown Relay: Rated to interrupt fan motor-control circuit. Where fan's shut-down circuitry requirements exceeds rating of relay contacts, provide an interposing relay at the smoke detector to accomplish shut-down.

2.6 ADDRESSABLE HEAT DETECTORS

A. Addressable Thermal Detector: Combination fixed-temperature and rate-of-rise unit with mounting plate arranged for outlet box mounting; 135 deg F fixed-temperature setting, except as indicated. The device shall be capable of transmitting an up-to-date temperature reading at the fire alarm control panel.

2.7 ALARM-INDICATING DEVICES

A. General: Equip alarm-indicating devices for mounting as indicated. Provide terminal blocks for system connections. All devices shall comply with ADA.

B. Visual Alarm Devices: Xenon strobe lights with clear polycarbonate lens. Lenses shall be mounted on a metallic faceplate. The word "FIRE" shall be engraved in minimum 1-inch high letters on the device.
1. Strobe light candle rating shall be selected and installed in accordance with NFPA/ANSI Standards and shall provide Equivalent Facilitation outlined under ADA Accessibility Guidelines by meeting or exceeding the effective illumination of 75 candela at 50 feet.
2. Candela ratings and area served shall be as follows:
   a. 15 candela units: Spaces up to 20-foot x 20-foot.
   b. 30 candela units: Spaces up to 30-foot x 30-foot.
   c. 60 candela units: Spaces up to 40-foot x 40-foot.
   d. 95 candela units: Spaces up to 50-foot x 50-foot and larger

   NOTE: Where manufacturer's standard product does not match those ratings listed above, the manufacturer's next higher rated unit shall be utilized.

3. Strobe Leads: Factory connected to screw terminals.
4. Combination devices shall consist of a factory-combined, audible and visual alarm unit in a single mounting assembly.
5. All strobe lights in each building shall be provided with a synchronized flash feature.

C. Voice/Tone Speakers: Comply with UL 1480.
1. Matching Transformer: 25 and 70 VRMS inputs
2. Taps: 1/4, 1/2, 1, and 2 watts

3. Speaker: 4-inch cone type with 4.8 oz. ceramic magnet
4. Mounting: Flush, ceiling mount with backbox and tile bridge.
5. Mounting: Semi-recessed wall mount in combination A/V units.
6. Baffle: Metal baffle painted white, 6-inch diameter.

2.8 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Description: Provide an LED-indicating light in the vicinity of each sprinkler water-flow switch, valve tamper switch, and duct mounted smoke detector to denote the associated device is in an abnormal or trouble mode. Lamp shall be flush mounted on a single gang wall plate. Provide a red, laminated, phenolic-resin identification plate at the indicating light identifying, in engraved white letters, the room where the valve is located or the protected spaces downstream from the water-flow switch.

2.9 MAGNETIC DOOR HOLDER

A. Provide a two-piece electromagnetic door holder designed to secure a door in the open position. Provide device with the following features:
1. Flush wall mount, low-profile magnet.
2. Operating voltage compatible with power supply of FACP.
   a. Three position wiring terminal block (common, low voltage, high voltage) with ground.
3. Door mounted strike with self-adjusting swivel catch plate.
   a. Two-point pivot.
   b. Surface mounted back-plate for strike (hollow doors only).
4. Holding force of 25 pounds minimum.
5. Low residual magnetism.
6. Cast metallic housing for magnet and strike assemblies.
   a. Finish: chrome.

2.10 SILENT ALARM PUSHBUTTONS

A. Provide a surface mounted silent alarm pushbutton assembly with the following features:
1. Two large levers on either side of the switch.
2. Both levers must be depressed simultaneously to activate the switch.
3. Lock-in mechanism with key reset.
4. Indicator to show switch has activated.
5. Metallic housing with screw holes for surface installation.
6. SPDT contacts.

2.11 FIRE ALARM CONTROL PANEL (FACP)

A. General: Comply with UL 864.

B. Cabinet: Lockable steel semi-recessed enclosure. Panel shall be arranged so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control panel, exactly matching modular unit enclosures shall be provided. Accommodate all components and allow ample gutter space for interconnection of panels and field wiring. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate. Lettering on the enclosure's

nameplate shall not be less than 1 inch high. Identify individual components and modules within the cabinets with permanent labels.

C. Systems: Alarm and supervisory systems shall be separate and independent in the FACP. The alarm-initiating zone boards in the FACP shall consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.

D. Control Modules: Types and capacities required to perform all functions of the fire alarm systems. Local, visible, and audible signals shall announce alarm, supervisory, and trouble conditions. Each type of audible alarm shall have a different sound.

E. Zones: Provide for all alarm and supervisory zones indicated.

F. Indicating Lights: A single LED test switch for each FACP section shall be provided to illuminate all LED indicators on that section of the control panel. Alarm and supervisory signal lights shall utilize red LEDs. Trouble signal lights shall utilize amber LEDs.

G. Resetting: Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition still exists.

H. Alphanumeric Display and System Controls: Arranged to provide the basic interface between human operator at the FACP and the addressable system components, including annunciation, supervision, and control. Provide a display with a minimum of 32 characters to indicate alarm, supervisory, component status messages, and control commands entered into the system for control of smoke detector sensitivity and other parameters. Provide a keypad for use in entering and executing control commands.

I. Voice Alarm: Provide an emergency communication system, integral with the FACP, including central voice alarm system components complete with microphones, preamplifiers, amplifiers, and tone generators. Features shall include the following:
   1. Amplifiers shall comply with UL 1711.
   2. The system shall be capable of broadcasting a general alarm prerecorded voice message and simultaneously broadcasting a live voice evacuation message to selected zones via the fire fighter's zone selected switches and the central control microphone.
   3. All announcements shall be made over dedicated, supervised communication lines.
   4. Provide status annunciators to indicate the status of the various voice alarm speaker zones and the status of firefighter telephone 2-way communication zones.

J. Instructions: Printed or typewritten instruction cards shall be mounted behind a lexan plastic or glass cover in a stainless-steel or aluminum frame. Install the frame in a location observable from the FACP. The instruction card(s) shall include interpretation and appropriate response for displays and signals, and briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.12 FIRE ALARM MULTIPLEXER PANEL (FMUX)

A. General: Comply with UL 864.

B. Cabinet: Lockable steel surface mounted enclosure. Panel shall be arranged so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control panel,

exactly matching modular unit enclosures shall be provided. Accommodate all components and allow ample gutter space for interconnection of panels and field wiring. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate. Lettering on the enclosure's nameplate shall not be less than 1 inch high. Identify individual components and modules within the cabinets with permanent labels.

C. Systems: Alarm and supervisory systems shall be separate and independent in the FMUX. The alarm-initiating zone boards in the FMUX shall consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.

D. Control Modules: Types and capacities required to perform all functions of the fire alarm systems. Local, visible, and audible signals shall announce alarm, supervisory, and trouble conditions. Each type of audible alarm shall have a different sound.

E. Communication: Provide a communication bus between the fire alarm control panel (FACP) and multiple multiplexer panels (FMUX). All alarm, supervisory and trouble conditions originating at the FMUX shall be annunciated locally at the FMUX, the FACP, and each annunciator. Arrange so that system programming is performed at the FACP only.

F. Zones: Provide for all alarm and supervisory zones indicated.

G. Indicating Lights: A single LED test switch for each FMUX section shall be provided to illuminate all LED indicators on that section of the control panel. Alarm and supervisory signal lights a red LED. Trouble signal lights shall utilize an amber LED.

H. Resetting: Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition still exists.

2.13 GRAPHIC ANNUNCIATOR

A. Annunciator Panel: Provide a schematic building section that indicates each alarm and supervisory initiating device (see detail on Plans). Provide an LED-indicating light for each device. Provide lights that indicate the floor on which a signal was actuated. Engrave floor designations on the face of the annunciator.

B. Indicating lights include individual LED indicators for each type of alarm and supervisory device and an LED to indicate system trouble. The actuation of any alarm or supervisory signal shall cause the illumination of a floor light and device light. System trouble causes the illumination of the system trouble light. Additional LEDs shall be provided to indicate normal and emergency power modes for the system. A single LED test switch shall be provided to illuminate all LED indicators on the annunciator.

C. Faceplate: Satin-finished stainless steel or brushed aluminum. Floor plan lines shall be engraved in the faceplate and filled with colored paint. Engraved legends for the panel LEDs and switches shall be 1/4 inch high minimum, in letters filled with red paint. Device LEDs shall utilize a machine written legend plate, removable, and capable of being updated.

D. Cabinet: Flush mounted, lockable, stainless steel frame with clear flexiglass cover. Cover shall have full length, stainless steel piano hinge. Unit shall be provided with sufficient backbox to house all components with ample wire gutter space to terminate field wiring. All field wiring shall terminate on screw type terminal strips.

2.14 SYSTEM PRINTER

A. General: Provide a system printer that is listed and labeled as an integral part of the fire alarm system.
   1. Should the system printer be a separate component from the fire alarm control panel and require an individual power circuit, a 20 amp duplex receptacle shall be provided to serve the printer. The receptacle shall be flush mounted in the security control room (at a location as directed by the Engineer) and circuited to a dedicated 20 amp, 1 pole, circuit breaker to the nearest 120/208 volt, 3 phase, 4 wire, emergency power panelboard.
   2. Printer shall be dot matrix and capable of using wide, track-fed, fan fold paper.

2.15 EMERGENCY POWER SUPPLY

A. General: Components shall include a nickel-cadmium-type battery, charger, and an automatic transfer switch. Battery nominal life expectancy shall be 20 years, minimum.

B. Battery capacity shall be adequate to operate the complete alarm system in normal or supervisory (nonalarm) mode for a period of 24 hours. At the end of this period, the battery shall have sufficient capacity to operate the system, including alarm-indicating devices in either alarm or supervisory mode, for a period of 15 minutes.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged, the charger shall recharge them completely within 4 hours. Charger output shall be supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: The transfer switch shall transfer the load to the battery without loss of signals or status indications when normal power fails.

2.16 WIRE

A. General: All power, signal and control wiring shall meet the requirements of NEC Article No. 760 "Fire Alarm Systems", and other articles as applicable.

B. Wire: Provide solid-copper conductors with 600 volt rated, 75 deg C, color-coded insulation.
   1. Low-Voltage Circuits: No. 14 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.

C. Signal Cables: Provide factory fabricated multiconductor signal cables with No. 18 AWG copper conductors (minimum). Individual conductors shall be bare, soft annealed copper, PVC insulated with nylon outer jacket. Cables shall include overall shield, drain wire, and PVC jacket.

D. Fire Fighter Telephone Cables: Provide factory fabricated multiconductor signal cables with No. 18 AWG copper conductors (minimum). Individual conductors shall be bare, soft annealed copper, PVC insulated with nylon outer jacket. Cables shall include overall shield, drain wire, and PVC jacket.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system according to NFPA standards referenced to Parts 1 and 2 of this Section.

B. Fire Alarm Power Supply Disconnect: Paint red and label “FIRE ALARM”. Provide with lockable handle or cover.

C. System installer must be certified by the State Fire Marshal to install fire detection systems. Contractor to furnish evidence of certification to the Engineer.

3.2 EQUIPMENT INSTALLATION

A. Manual Pull Stations: Mount semiflush in recessed back boxes with operating handles 48 inchesabove the finished floor.

B. Water-Flow Detectors, Valve Supervisory Switches, and Pressure Sensors: Connect for each sprinkler valve station required to be supervised. Provide each component with an external addressable interface unit.

C. Smoke Detectors: install ceiling-mounted detectors at locations as indicated on Plans.

D. Duct-Mounted Smoke Detectors: Install duct-mounted smoke detectors where indicated on Plans. The Plans indicate installation locations and do not reflect actual quantity. The E.C. shall coordinate with the Mechanical Contractor to determine quantity and physical arrangement of detectors. The E.C. shall provide the necessary quantity and arrangement for compliance with NFPA 72.

E. Alarm-Indicating Devices: Install wall-mounted visual and combination audio/visual appliances 80 inchesabove the finished floor or 6 inches below ceiling, whichever is lower. Install ceiling mounted audio appliances on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

F. Remote Device location-Indicating Lights: Install device location indicators on wall 80 inches above finished floor or 6 inches below ceiling, whichever is lower, unless noted otherwise.

G. Control Panels and Equipment Cabinets: Surface/semi-surface mount with tops of cabinets 72 inchesabove the finished floor.

H. Graphic Annunciator: Flush mount with the top of the panel 72 inchesabove the finished floor.

3.3 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway according to Division 26 Section “Raceways”. Conceal raceway except in unfinished spaces and as indicated.

B. Wiring within Enclosures: Conductors shall be installed parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system’s wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and a different color code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visual alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

3.5 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at fire alarm control panel (FACP). Isolate from power system and equipment grounding. Extend #4 insulated ground conductor in 3/4-inch Schedule 80 PVC conduit under the raised access floor to ground bus in nearest telecommunication closet. Label ground conductor "Fire Alarm System Ground".

C. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm isolated ground at FACP location. Measure, record, and report ground resistance.

3.6 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed, that are packaged with protective covering for storage, and that are identified with labels clearly describing contents.
   1. Glass Rods for Manual Stations: Furnish 24 rods.
   2. Ceiling Speakers: Furnish 8 complete assemblies.
   3. Wall Mounted A/V Units: Furnish 4 complete assemblies.
   4. Smoke Detectors: Furnish 12 detectors.
   5. Detector Bases: Furnish 4 bases.
   6. Printer Ribbons: Furnish 6 ribbons.
   7. Printer Paper: Furnish 12 rolls (2 boxes) of premium paper.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of

the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
   1. Verify the absence of unwanted voltages between circuit conductors and ground.
   2. Test all conductors for short circuits using an insulation-testing device.
   3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
   4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
   5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
   6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
   7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communication options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
   8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.8 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

B. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests. A copy of the test reports shall be included in the Owner's O&M Manual.

C. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.9 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.
   1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of 16 hours' training,
   2. Train security room operators on procedures and schedules related to start-up, operation, and shut-down of the fire alarm system. Provide a minimum of four 4-hour training sessions.
   3. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
   4. Schedule training with Owner with at least 7 days' advance notice.

3.10 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to 3 requested adjustment visits to the site for this purpose.

END OF SECTION 28 3100

SECTION 31 0519.13

GEOTEXTILES FOR EARTHWORK

PART 1 - GENERAL

1.1 SCOPE

A. Contractor shall provide all labor, materials, equipment, and services required to provide and place geosynthetics as shown and specified.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus
      b. ASTM D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity
      c. ASTM D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles
      d. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
      e. ASTM D4751, Standard Test Methods for Determining Apparent Opening Size of a Geotextile
      f. ASTM D6241, Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:s
   1. Geotextile manufacturer shall be listed on the Ohio Department of Transportation Office of Materials Management Approved List.
   2. Geotextile manufacturer shall be a specialist in the manufacture of geotextile filter fabric, and have produced and successfully installed a minimum of five million square feet.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
   2. Submit geotextile manufacturer's data, specifications, installation instructions and dimensions.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Each roll of geotextile delivered to the Site shall be labeled by the manufacturer identifying the manufacturer's name, product identification, lot number, roll number and roll dimensions.

B. All rolls and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer if any loss or damage exists to geotextile filter fabric. Replace loss and repair damage to new condition, in accordance with manufacturer’s instructions.

C. Geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

PART 2 - PRODUCTS

2.1 GEOTEXTILE FILTER FABRIC

A. Provide woven or non-woven fabric composed of polymeric fibers which are formed into a stable network such that the filaments retain their relative position. The fabric shall be inert to biological degradation and naturally encountered chemicals, alkalizes, and acids.

B. All minimum strengths for geotextile filter fabrics are in the weakest principal direction.

C. Type A: Underdrains and Slope Drains
1. Product and Manufacturer: Provide the following:
   a. Mirafi 140 NL by TenCate Geosynthetics,
   b. 0311T by ADS Geosynthetics,
   c. FX-30HS by Carthage Mills,
   d. Or Equal.
2. Geotextile filter fabric shall conform to the following:

Property	Value	Test Method
Minimum tensile strength	80 lb	ASTM D4632
Minimum puncture strength	140 lb	ASTM D6241
Minimum tear strength	25 lb	ASTM D4533
Apparent opening size	≤ 0.3 mm	ASTM D4751
Minimum permittivity	2.0/sec	ASTM D4491
Minimum water flow rate	140 gpm/ft²	ASTM D4491

D. Type B: Filter Blankets for Rock Channel Protection
1. Product and Manufacturer: Provide the following:
   a. Mirafi 180 N by TenCate Geosynthetics,
   b. 0801T by ADS Geosynthetics,
   c. FX-80HS by Carthage Mills,
   d. Or Equal.
2. Geotextile filter fabric shall conform to the following:

Property	Value	Test Method
Minimum tensile strength	200 lb	ASTM D4632
Minimum elongation	15%	ASTM D4632
Minimum puncture strength	440 lb	ASTM D6241
Minimum tear strength	50 lb	ASTM D4533
Apparent opening size	≤ 0.6 mm	ASTM D4751
Minimum permittivity	0.2/sec	ASTM D4491

E. Type C: Sediment Fences
   1. Geotextile filter fabric shall conform to the following:

Property	Value	Test Method
Minimum tensile strength	120 lb	ASTM D4632
Maximum elongation	50%	ASTM D4632
Minimum puncture strength	275 lb	ASTM D6241
Minimum tear strength	40 lb	ASTM D4533
Apparent opening size	≤ 0.84 mm	ASTM D4751
Minimum permittivity	0.01/sec	ASTM D4491
Ultraviolet exposure strength retention	70%	ASTM D4355

PART 3 - EXECUTION

3.1 INSPECTION:

A. Contractor shall examine the conditions under which the Work is to be installed and notify the Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General
   1. All geotextiles shall be weighted with sandbags or the equivalent when required. Such sandbags shall be installed during placement and shall remain until replaced with cover material or geomembrane.
   2. Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
   3. During placement of geotextiles, care shall be taken not to entrap in the geotextile stone, excessive dust, or moisture that could damage the geomembrane, generate clogging, or hamper subsequent seaming.
   4. Geotextiles shall not be exposed to precipitation prior to being installed, and shall not be exposed to direct sunlight for more than 15 days.

B. Type A: Underdrains and Slope Drains
   1. Place the Geotextile Fabric to completely surround the granular material. Overlap the Geotextile Fabric at the top of the trench. Match the overlap to the trench width. At other seams, overlap Geotextile Fabric a minimum of 12 inches.

C. Type B: Filter Blankets for Rock Channel Protection
   1. Prepare the surface to receive the fabric to a relatively smooth surface, free of obstruction and debris. With the long dimension parallel to the flow direction, loosely place the fabric without wrinkles and creases. Where joints are necessary, provide a 12-inch minimum overlap, with the upstream strip overlapping the downstream strip. Place securing pins with washers at a minimum distance apart of 2 feet along the joints and at a minimum distance apart of 5 feet everywhere else.

3.3 GEOTEXTILE REPAIR:

A. Any holes or tears in the fabric shall be repaired as follows:

1. On slopes: A fabric patch shall be sewn into place using a double sewn lock stitch (1/4-inch to 3/4-inch apart and no closer than 1-inch from any edge). Should any tear exceed ten percent of the width of the roll, that roll shall be removed from the slope and replaced.
2. Non-slopes: A fabric patch shall be spot-seamed in place with a minimum of 24-inches of overlap in all directions.

3.4 PLACEMENT OF COVER MATERIALS:

A. Contractor shall place all cover materials in such a manner to ensure the geotextile is not damaged; minimal slippage of the geotextile on underlying layers; and no excess tensile stresses in the geotextile.

END OF SECTION 31 0519.13

SECTION 31 0519.33

TIED CONCRETE BLOCK MATS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Contractor shall provide all labor, materials, equipment, and services required to provide tied concrete block mats as shown and specified.

1.2 REFERENCES:

A. American Society for Testing and Materials, (ASTM).
   1. ASTM C150, Standard Specification for Portland Cement.
   2. ASTM C33, Standard Specification for Concrete Aggregates.
   3. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   4. ASTM D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus
   5. ASTM D6475, Standard Test Method for Measuring Mass per Unit Area of Erosion Control Blankets
   6. ASTM D6524, Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats (TRMs)
   7. ASTM D6525, Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products
   8. ASTM D6566, Standard Test Method for Measuring Mass Per Unit Area of Turf Reinforcement Mats
   9. ASTM D6567, Standard Test Method for Measuring the Light Penetration of a Rolled Erosion Control Product (RECP)
   10. ASTM D6818, Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products

B. Erosion Control Technology Council (ECTC).
   1. Current Standards.

1.3 QUALITY ASSURANCE:

A. Product shall be listed on the Ohio Department of Transportation Qualified Products List.

1.4 SUBMITTALS:

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Submit manufacturer's data, specifications, manufacturer approved mat layout design including location and type of joints, installation instructions and dimensions.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Each roll of geotextile delivered to the Site shall be labeled by the manufacturer identifying the manufacturer's name, product identification, lot number, roll number and roll dimensions.

B. All rolls and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer if any loss or damage exists to geotextile filter fabric. Replace loss and repair damage to new condition, in accordance with manufacturer’s instructions.

C. Chipping or missing concrete resulting in a weight loss exceeding 15% of the average weight of a concrete unit is grounds for rejection by the Engineer. Replace, repair, or patch the damaged areas per the manufacturer’s recommendations.

D. Cover the mat or otherwise protect it during long periods of storage to protect against degradation of the backing material as recommended by the manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL:

A, Tied concrete block mats shall be manufactured from individual concrete blocks tied together with high strength polypropylene bi-axial geogrid. Each block is tapered, beveled and interlocked, and includes connections that prevent lateral displacement of the blocks within the mats when they are lifted for placement.

B. Tied concrete block mats shall be Flexamat, manufactured by Motz Enterprises, Inc. or approved equal.

2.2 BLOCKS:

A. Furnish blocks manufactured with concrete conforming to the cement requirements of ASTM C150 and to the aggregate requirements of ASTM C33. Meet a minimum compressive strength of 5,000 psi at 28 days. Furnish blocks that have a minimum weight of 3 lb. per block. Blocks shall be placed no further than 2 in. apart.

2.3 POLYPROPYLENE BI-AXIAL GEOGRID:

A. Provide revetment mat that is constructed of a high tenacity, low elongating, and continuous filament polypropylene fibers that is securely cast into and embedded within the base of the concrete blocks and obtains connection strength greater than that of the geogrid. The geogrid shall meet the following requirements:
   1. UV Stabilization: 2% Carbon Black
   2. Ultimate Tensile Strength: 2055 lb/ft

2.4 UNDERLAYMENT:

A. Degradable erosion control blanket
   1. Provide a degradable erosion control blanket in accordance with the following requirements:
      a. Thickness: 0.418 in, ASTM D6525
      b. Light Penetration: 34.6 %, ASTM D6567

c. Resiliency: 64%, ASTM D6524
d. Mass per Unit Area: 0.57 lb/yd², ASTM D6475
e. MD-Tensile Strength, Max: 127.0 lb/ft, ASTM D6818
f. TD-Tensile Strength, Max: 50.9 lb/ft, ASTM D6818
g. Swell: 89%, ECTC Procedure
h. Bench-Scale Rain Splash: Soil Loss Ratio = 6.84 @ 2 in/hr, ECTC Method 2
i. Bench-Scale Rain Splash: Soil Loss Ratio = 7.19 @ 4 in/hr, ECTC Method 2
j. Bench-Scale Rain Splash: Soil Loss Ratio = 7.56 @ 6 in/hr, ECTC Method 2
k. Bench-Scale Shear: 2.6 lb/ft2 @ 0.5 in soil loss, ECTC Method 3
l. Germination Improvement: 645% ECTC Method 4

B. Non-degradable erosion control blanket
1. Provide a degradable erosion control blanket in accordance with the following requirements:
a. Thickness: 0.294 in, ASTM D6525
b. Light Penetration: 57%, ASTM D6567
c. Resiliency: 86%, ASTM D6524
d. Mass per Unit Area: 0.50 lb/yd², ASTM D6566
e. MD-Tensile Strength Max: 295.2 lb/ft, ASTM D6818
f. TD-Tensile Strength Max: 194.4 lb/ft, ASTM D6818
g. MD-Elongation: 32.2%, ASTM D6818
h. TD-Elongation: 40.8%, ASTM D6818
i. Swell: 8%, ECTC Procedure
j. Specific Gravity: 1.21, ASTM D792
k. UV Stability: 80% minimum, ASTM D4355 (1,000 hr)
l. Bench-Scale Rain Splash: SLR = 5.86 @ 2 in/hr, ECTC Method 2
m. Bench-Scale Rain Splash: E SLR = 5.00 @ 4 in/hr, CTC Method 2
n. Bench-Scale Rain Splash: SLR = 6.33 @ 6 in/hr, ECTC Method 2
o. Bench-Scale Shear: 2.41 lb/ft2 @ 0.5 in soil loss, ECTC Method 3
p. Germination Improvement: 432%, ECTC Method 4

PART 3 - EXECUTION

3.1 INSPECTION:

A. Contractor shall examine the conditions under which the Work is to be installed and notify the Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION – GENERAL:

A. Install tied concrete block mats in accordance with manufacturer's installation instructions.

B. Prior to installing tied concrete block mats, prepare the subgrade as detailed in the plans. All subgrade surfaces to be smooth and free of all rocks, stones, sticks, roots, and other protrusions or debris of any kind that would result in an individual block being raised more than 3/4 in. above the adjoining blocks. When seeding is shown on the plans, provide subgrade material that can sustain growth.

C. Ensure the prepared subgrade provides a smooth, firm, and unyielding foundation for the mats. The subgrade shall be graded into a parabolic or trapezoidal shape to concentrate flow to middle of mat or mats.

D. When vegetation is required, distribute seed on the prepared topsoil subgrade before installation of the concrete mats in accordance with the specifications.

E. Install mats to the line and grade shown on the plans and per the manufacturer's guidelines. The manufacturer or authorized representative will provide technical assistance during the slope preparation and installation of the concrete block mats as needed.

F. Provide a minimum 18 in. deep concrete mat embedment toe trench at all edges exposed to concentrated flows. Recess exterior edges subject to sheet flow a minimum of 3 in.

G. When needed, provide fastening or anchoring as recommended by the manufacturer or engineer for the site conditions.

H. All geotextiles shall be weighted with sandbags or the equivalent when required. Such sandbags shall be installed during placement and shall remain until replaced with cover material or geomembrane.

I. For seams parallel to the flow line in ditch or channel applications, center a minimum 3 ft. wide strip of soil retention blanket under the seam. Fasten along the seam at 5 ft. maximum spacing. Parallel seams in the center of the ditch shall be avoided when possible.

J. Shingle seams perpendicular to the flow line with the downstream mat recessed a minimum of 2 blocks or 12 inches of extended underlayment under the upstream mat and fastened together along the seam at 2 ft. maximum spacing if required by manufacturer or engineer.

END OF SECTION 31 0519.33

SECTION 31 1100

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals required to perform clearing and grubbing as shown and specified in the Contract Documents.
2. The Work includes removing from the Site and disposing of trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material.
3. Pay all costs associated with transporting and disposing of debris resulting from clearing.
4. Limits of Clearing and Grubbing Work: Clear and grub all areas within the Work areas unless otherwise shown or indicated in the Contract Documents.

B. Related Sections:
1. Section 01 5705, Temporary Controls.
2. Section 02 4100, Demolition.
3. Section 32 0191, Tree Protection and Trimming.

1.2 QUALITY ASSURANCE:

A. Professional Arborist Qualifications:
1. Engage an accredited professional arborist, acceptable to Engineer, skilled, trained and with successful and documented experience in the protection and restorative care of trees, certified by the International Society of Arboriculture or American Society of Consulting Arborists; who agrees to employ only tradesmen with specific skill and successful experience in this type of Work.

B. Regulatory Requirements:
1. Laws and Regulations applying to the Work under this Section include, but are not necessarily limited to, the following:
a. Perform tree clearing only between October 15 and March 31

1.3 SUBMITTALS:

A. Action Submittals: Submit the following
1. Shop Drawings:
a. Plan for removing trees and other large vegetation not explicitly shown or indicated for removal in the Contract Documents.
b. Plan showing proposed limits of clearing and grubbing, if different from clearing and grubbing limits shown or indicated in the Contract Documents.

B. Informational Submittals: Submit the following
1. Qualification Statements:
a. Arborist.

1.4 WARRANTY

A. Contractor shall warrant that Work performed under this Section will not permanently damage trees, shrubs, turf, and plants designated to remain, or other adjacent work, facilities, or property. If damage resulting from Contractor's operations becomes evident during the correction period, Contractor shall replace damaged items and property at no additional cost to Owner.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION:

A. Protection:
   1. Throughout the Project, protect existing site improvements, including streets, drives, and Underground Facilities to remain (if any), and adjacent property and structures. Repair damage caused by Contractor to original condition or replace in kind, to satisfaction of Engineer, at no additional cost to Owner.
   2. Protect trees, shrubs, vegetation, and grassed areas to remain by providing temporary fencing, barricades, wrapping, or other methods shown, specified, or accepted by Engineer. Correct at Contractor's expense damage caused by Contractor outside the limits of clearing Work.
   3. Do not remove trees without approval of Engineer, unless shown or indicated for removal.
   4. Do not locate construction equipment, stored materials, or stockpiles within drip line of trees and vegetation to remain.

B. Site Preparation:
   1. Obtain, pay costs associated with, and comply with applicable permits required for clearing and grubbing Work.
   2. Delineation of Clearing and Grubbing Limits:
      a. Locate and clearly flag trees and vegetation to remain, and other materials to remain in the clearing and grubbing limits. Locate and clearly flag salvable vegetation to be relocated.
      b. Provide flagging to delineate limits of areas to be cleared or grubbed. Review at Site with Engineer before commencing removal of trees, vegetation, and other materials to be removed.
      c. Replace flagging that is lost, removed, or destroyed, until clearing and grubbing Work is complete and Engineer allows removal of flagging.
   3. Erosion and Sediment Controls:
      a. Provide applicable erosion and sediment controls before commencing clearing and grubbing Work.
      b. Comply with Section 01 4126, Stormwater Pollution Prevention Plan and Permit
      c. Comply with erosion and sediment control requirements of Section 01 5705, Temporary Controls.
      d. Continue providing erosion and sediment controls as clearing and grubbing Work progresses to previously uncleared, ungrubbed areas of the Site.

3.2 CLEARING AND GRUBBING:

A. Remove and dispose of all trees, shrubs, stumps, roots, brush, logs, rubbish, and debris within limits of clearing and grubbing shown or indicated in the Contract Documents, unless otherwise shown or indicated.

B. Trees and Shrubs Improperly Destroyed or Damaged:
   1. For each tree or shrub to remain that is destroyed or damaged beyond repair by Contractor, provide two replacements of the same species at locations to be designated by Engineer.

C. Trees and shrubs to remain that have been damaged or require trimming shall be treated and repaired under the direction of a qualified arborist, or other professional with qualifications acceptable to Engineer. Trees and shrubs intended to remain, that are damaged beyond repair or that are removed, shall be replaced by Contractor at no additional cost to Owner.

D. Salvable Vegetation:
   1. Trees, shrubs, and other vegetation requiring removal to facilitate the Work, and that will be transplanted elsewhere at the Site, shall be carefully balled and burlapped or placed in temporary pots, and stored at the Site in an acceptable area. Work involving removing and relocating trees, shrubs, and other vegetation shall be under the direction of qualified arborist acceptable to Engineer, or other professional acceptable to Engineer, hired by Contractor.

E. Disposal of Cleared and Grubbed Materials:
   1. Dispose at appropriate off-Site location trees, stumps, rubbish, debris, and other cleared and grubbed material. Cleared or grubbed materials may remain at the Site only when allowed in the Contract Documents or when approved by Engineer in writing. Do not use cleared or grubbed material as fill, backfill, or in embankments.
   2. Dispose of cleared and grubbed material in accordance with Laws and Regulations.
   3. Do not burn clearing debris at the Site, unless approved by Owner and authorities having jurisdiction. If burning is permitted, comply with requirements of authorities having jurisdiction and Laws and Regulations. If burning is permitted at the Site, also comply with Owner's requirements.

3.3 TOPSOIL REMOVAL:

A. Existing topsoil to be removed is defined as friable, clay loam, surface soil present in depth of at least four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material.

B. Stripping:
   1. Strip topsoil to depths encoun¬tered, in manner that prevents intermingling of topsoil with underlying subsoil or other objectionable material. Remove heavy growths of grass and vegetation from areas before stripping.
   2. Do not strip topsoil from within drip line of each tree to remain as part of the completed Project.

C. Stockpile topsoil in storage stockpiles in areas shown, or where otherwise accepted by Engineer. Construct storage piles so that surface water drains freely. Stabilize large topsoil piles with a cover crop and mulch, and provide silt fencing around perimeter of pile to prevent topsoil erosion and sedimentation; silt fencing shall be in accordance with Section 01 5705, Temporary Controls.

Cover smaller topsoil stockpiles, when used, with reinforced fabric to prevent windblown dust. Topsoil in excess of the quantity required for the finished Project shall remain property of Owner.

END OF SECTION 31 1100

SECTION 31 2305

EXCAVATION AND FILL

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of structures, Underground Facilities, roads, and other facilities required to complete the Work.
2. Preparation of subgrade for slabs and pavements is included under this Section.
3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

1.2 REFERENCES:

A. Standards referenced in this Section are:
1. ACI 522R, Pervious Concrete.
2. ANSI/AISC 360, Specification for Structural Steel for Buildings.
3. ASTM C29/C29M, Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
4. ASTM C33/C33M, Specification for Concrete Aggregates.
5. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
6. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
7. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
8. ASTM C150/C150M, Specification for Portland Cement.
9. ASTM C595/C595M, Specification for Blended Hydraulic Cements.
10. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
11. ASTM C989, Specification for Slag Cement for Use in Concrete and Mortars.
12. ASTM D422, Test Method for Particle-Size Analysis of Soils.
13. ASTM D448, Classification for Sizes of Aggregate for Road and Bridge Construction.
14. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).
15. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
16. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
17. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
18. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
19. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
20. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

21. ASTM D4832, Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
22. ASTM D6023, Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
23. ASTM D6103, Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).
24. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
25. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.3 TERMINOLOGY:

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "Subgrade" is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.

1.4 QUALITY ASSURANCE:

A. Qualifications:
   1. Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice in the same jurisdiction as the Site and experienced in providing engineering services of the kind indicated.
      b. Responsibilities include but are not necessarily limited to:
         1) Reviewing system performance and requirements shown or indicated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance and requirements for submittal to Engineer by Contractor.
         3) Preparing or supervising the preparation of design calculations and related submittals verifying compliance of the system with the requirements of the Contract Documents.
         4) Signing and sealing all calculations, drawings, and submittals prepared by professional engineer.
         5) Certifying that:
            (a) it has performed the design of the system in accordance with the performance requirements stated in the Contract Documents, and
            (b) the said design conforms to Laws and Regulations, and to the prevailing standards of practice.

B. Quality Assurance Testing:
   1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.
   2. Materials used in the Work may require testing and retesting, as directed by Engineer, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at Owner's expense, including retesting of rejected materials and installed Work, shall be performed at Contractor's expense.
   3. Contractor's Testing Laboratory Scope:
      a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.

b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
c. Design controlled low-strength material (CLSM) mixes in accordance with requirements of CLSM Article in Part 2 of this Section. Perform concrete materials evaluation tests and testing of CLSM mixes.
d. Submit to Engineer and Contractor written report results of each test.

4. Required Quality Assurance Material Testing by Contractor's Testing Laboratory:
   a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
   b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
   c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 5,000 cubic yards of the following types of materials incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
   d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
   e. CLSM Mix: Verify CLSM mix design by laboratory trial batch, unless indicated otherwise. Perform the following testing on each concrete mix trial batch:
      1) Aggregate gradation.
      2) Flowability, in accordance with ASTM D6103.
      3) Air content, in accordance with ASTM D6023.
      4) Unconfined compressive strength of CLSM mixes at 90 days, in accordance with ASTM D4832.
      5) Submit for each concrete mix trial batch the following information:
         (a) Project identification name and number (if applicable).
         (b) Date of test report.
         (c) Complete identification of aggregate source of supply.
         (d) Tests of aggregates for compliance with the Contract Documents.
         (e) Brand, type, and composition of cementitious materials.
         (f) Brand, type, and quantity of each admixture.
         (g) Quantity of water used in trial mixes.
         (h) Proportions of each material per cubic yard.
         (i) Gross weight and yield per cubic yard of trial mixtures.
         (j) Measured flowability.
         (k) Measured air content.
         (l) Unconfined compressive strength.
   f. Requirement for trial batch may be waived by Engineer if sufficient field test data documenting compliance with specified material properties and performance properties is submitted to and accepted by Engineer. Tests shall have been made on concrete with identical mix design to mix design proposed for the Work, including sources of aggregate and manufacturers of cementitious materials and admixtures.

C. Regulatory Requirements:
   1. Perform excavation work in compliance with require¬ments of authorities having jurisdiction and Laws and Regulations, including:
      a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).

2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.5 SUBMITTALS:

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. List of pervious concrete and CLSM materials and mix designs proposed for use. Include results of quality assurance testing performed to qualify the materials and to establish the mix designs.
      b. Laboratory Trial Batch Reports: Submit laboratory quality assurance test reports for materials and mix design tests.
      c. Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.
   2. Product Data:
      a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures to be used in pervious concrete mixes and CLSM mixes.

B. Informational Submittals: Submit the following:
   1. Procedure Submittals:
      a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
         1) Name of Contractor's "competent person" in responsible charge of excavation and fill Work.
         2) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
         3) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.
      b. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
   2. Quality Assurance Test Results Submittals:
      a. Submit results of quality assurance testing performed by in accordance with Paragraph 1.4.B of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
         1) Tests on borrow fill material.
         2) Optimum moisture – maximum dry density curve for each type of fill material.
   3. Field Quality Control Submittals:
      a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
         1) Field density testing.
         2) Tests of actual unconfined compressive strength or bearing tests of each stratum.
   4. Qualifications Statements:
      a. Professional engineer.

b. Quality Assurance Testing laboratory. Submit name and qualifications of testing laboratory to be employed, and qualifications of testing laboratory's personnel that will perform quality assurance testing required in this Section.

c. Field Quality Control Testing Laboratory: Names and qualifications of testing laboratory employed, and qualifications of testing laboratory's personnel that will perform field quality control testing as required under this Section.

1.6 SITE CONDITIONS:

A. Subsurface Information: The Supplementary Conditions indicate information available relative to subsurface conditions at the Site. Such information and data is not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by Contractor. Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor.

B. Soil borings and other exploratory operations may be made by Contractor, at no additional cost to Owner. Coordinate Contractor-performed test borings and other exploratory operations with Owner and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of Owner or utility owners. Comply with Laws and Regulations relative to required notifications.

C. Existing Structures:

1. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. Contractor shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by Contractor. Immediately repair and restore existing structures and Underground Facilities damaged by Contractor without additional cost to Owner.
2. Movement or operation of construction equipment over Underground Facilities shall be at Contractor's sole risk and only after Contractor has prepared and submitted to Engineer and utility owners (as applicable), and received acceptance therefrom, a plan describing Contractor's analysis of the loads to be imparted and Contractor's proposed measures to protect structures and Underground Facilities during the Project.
3. Coordinate with utility owners for shut off of services in active piping and conduits. When required by utility owner, Owner will assist Contractor with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
4. In general, service lines and laterals to individual houses and businesses are not shown; however, Contractor shall assume that a service exists for each utility owner to each house, business, and property.
5. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by Engineer after acceptable temporary utility services are provided by Contractor for the affected structure or property.

PART 2 – PRODUCTS

2.1 MATERIALS:

A. Select Fill:
   1. Material shall be well-graded, crushed aggregate, free of organic material. Material shall be Item 304 in accordance with State of Ohio Department of Transportation Construction and Material Specifications.

B. General Fill:
   1. Material shall be free of: rock and gravel larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious matter.
   2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
   3. Previously-excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
   4. When on-Site materials are found unsuitable for use as general fill, provide select fill or approved off-Site general fill materials. Prior to using off-Site material as general fill, furnish submittal for and obtain Engineer's approval of the material proposed for use.

C. Subbase Material:
   1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Crushed slag is unacceptable. Material shall be No. 57 or Item 304 in accordance with State of Ohio Department of Transportation Construction and Material Specifications.

D. Aggregate Base:
   1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Crushed slag is unacceptable. Material shall be Item 304 in accordance with State of Ohio Department of Transportation Construction and Material Specifications.

E. Drainage Fill:
   1. Material shall be washed, uniformly-graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1.5-inch sieve and not more than five percent passing a No. 4 sieve.

F. Granular Back Fill
   1. Material shall be Item 304 or 411 in accordance with State of Ohio Department of Transportation Construction and Material Specifications.

G. Pipe Bedding Material:
   1. Aggregate material shall be crushed stone and gravel, free of debris, waste, frozen materials, organic material and other deleterious matter.
   2. For nominal pipe sizes less than 15" provide:
      a. AASHTO M43, No. 8 crushed stone.
   3. For nominal pipe sizes greater than or equal to 15" and less than or equal to 30" provide:
      a. AASHTO M43, No. 57 crushed stone, or
      b. AASHTO M43, No. 67 crushed stone, or
      c. Item 304 in accordance with State of Ohio Department of Transportation Construction and Material Specifications.

4. For nominal pipe sizes greater than 30" provide:
    a. AASHTO M43, No. 57 crushed stone, or
    b. Item 304 in accordance with State of Ohio Department of Transportation Construction and Material Specifications.

H. Mudmat shall be in accordance with Section 03 3000, Cast-in-Place Concrete.

I. Controlled Low Strength Material (CLSM):
1. CLSM shall be self-leveling and self-compacting cementitious material.
    a. Cement: Type I or Type II portland cement complying with ASTM C150/C150M.
    b. Fly Ash Mineral Admixture: Comply with ASTM C618, Class F.
    c. Water: Clean, potable.
    d. Admixtures: Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Do not use calcium chloride or admixtures containing chloride ions. Use only admixtures that have been tested and approved in the mix designs.
    e. Fine Aggregates: ASTM C33/C33M.
2. CLSM Mix:
    a. Cement Content: 50 pounds per cubic yard.
    b. Fly Ash Mineral Admixture: 250 pounds per cubic yard.
    c. Fine Aggregate Content: 2910 pounds per cubic yard.
    d. Water Content: 500 pounds per cubic yard.
    e. Admixtures shall comply with manufacturer's recommendations for use with CLSM.
    f. Unconfined compressive strength shall be not more than 100 psi.
    g. Adjustment of Mixes.
        1) Mix design adjustments may be requested by Contractor when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
        2) Submit for Engineer's approval laboratory test data for adjusted mix designs, including compressive strength test results.
        3) Implement adjusted mix designs only after Engineer's approval.
        4) Adjustments to mix designs shall not result in additional costs to Owner.

2.2 SOURCE QUALITY CONTROL:

A. Perform quality assurance testing, and submit results to Engineer, in accordance with the 'Quality Assurance" Article in Part 1 of this Section.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Provide Engineer with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. Engineer will advise Contractor in writing when Engineer is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 TEST PITS:

A. General:
1. In advance of the construction, excavate, make observations and measurements, and fill test pits to determine conditions or location of the existing Underground Facilities and structures. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for test pits. Contractor shall be responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting the affected Underground Facility or structure. Contractor shall be responsible for repairing, at his expense, damage to Underground Facility or structure caused during the Work.

3.3 PREPARATION:

A. Use of Explosives:
1. Use of explosives is not allowed.

B. Dust Control:
1. Control objectionable dust caused by Contractor's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to Engineer’s acceptance and approval of authorities having jurisdiction.

C. Maintenance and Protection of Traffic:
1. Keep all streets and traffic ways open for passage of traffic and pedestrians during the Project, unless otherwise approved by owner of the street, traffic way, or right-of-way, as applicable.
2. When required to cross, obstruct, or temporarily close a street or traffic way, provide and maintain suitable bridges, detours, and other acceptable temporary expedients to accommodate traffic. Closings of street or traffic way shall be for shortest time practical, and passage shall be restored immediately after completion of fill and temporary paving or bridging.
3. Give required advance notice to fire department, police department, and other emergency services as applicable of proposed construction operations.
4. Give reasonable notice to owners or tenants of private property who may be affected by construction operations. Give such notice not less than 7 days prior to construction that will affect the property.
5. Hydrants, valves, fire alarm boxes, postal boxes and delivery service boxes, and other facilities that may require access during construction shall be kept accessible for use.
6. Provide temporary signage, signals, barricades, flares, lights and other equipment, service, and personnel required to regulate and protect traffic and warn of hazards. Such Work shall comply with requirements of owner of right-of-way and authorities having jurisdiction at the Site. Remove temporary equipment and facilities when no longer required, and restore grounds to original or to specified condi¬tions, as applicable.

3.4 DEWATERING:

A. Dewatering – General:
1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and

continually thereafter until the structure to be built therein is acceptable to Engineer and backfilling operations are completed and acceptable to Engineer.

2. Keep all working areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes, and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.
3. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
4. Contractor shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.
5. Remove water from excavations as fast as water collects.

B. Temporary Dewatering System:

1. Contractor shall design, provide, and operate dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities, necessary to depress and maintain groundwater level 3 ft below the base of each excavation during all stages of construction operations.
2. Design and operate dewatering system to avoid settlement and damage to existing structures and Underground Facilities.
3. Groundwater table shall be lowered in advance of excavation for a sufficient period of time to allow dewatering of fine grain soils.
4. Maintain groundwater level at excavations two feet below lowest subgrade excavation until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural groundwater.
5. Operate dewatering system continuously, 24 hours per day, seven days per week. Provide standby pumping facilities and personnel to maintain the continued effectiveness of the system. Do not discontinue dewatering operations without first obtaining Engineer's acceptance for such discontinuation.
6. If, in Engineer's opinion, the water levels are not being lowered or maintained as required, provide additional or alternate temporary dewatering devices as necessary, at no additional cost to Owner.
7. Locate elements of temporary dewatering system to allow continuous dewatering operation without interfering with the Work to the extent practicable.
8. Where portions of dewatering system are located in the area of permanent construction, submit to and obtain Engineer's acceptance of details of proposed methods of constructing the Work at such location. Control of ground water shall continue until the permanent construction provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until waterproofing Work is completed.
9. Perform pumping of water from excavations in a manner that prevents carrying away of unsolidified concrete materials, and that avoids damaging the subgrade.
10. Before discontinuing dewatering operations or permanently allowing rise of groundwater level, prepare computations to demonstrate that structures affected by the water level rise are protected by fill or other means to sustain uplift. Use a safety factor of 1.25 when preparing such calculations.

C. Disposal of Water Removed by Dewatering System:
   1. Contractor's dewatering system shall discharge to a suitable location acceptable to the Owner, in accordance with Laws and Regulations.
   2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
   3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
   4. Dispose of water in manner that causes no inconvenience to Owner, others involved in the Project, and adjacent and downstream properties.

3.5 EXCAVATION:

A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits.

B. Excavation Protection:
   1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
   2. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   3. Excavations Greater Than Five Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   4. Provide and maintain excavation protection system(s) in accordance with submittals accepted by Engineer and required under Paragraph 1.5.B of this Section.

C. Maintain excavations in dry condition in accordance with "Dewatering" Article in Part 3 of this Section.

D. Elevation of bottom of footings shown is approximate. Engineer may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing.

E. When excavations are made below required grades without written order of Engineer, fill such excavations with compacted select fill material, as directed by Engineer, at Contractor's expense.

F. Extend excavations sufficiently on each side of struc¬tures, footings, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.

G. Subgrades – General:
   1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with crushed stone or gravel. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
   2. If, in Engineer's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within Contractor's control, subgrade

shall be excavated to firm material, trimmed, and backfilled with select fill material at Contractor's expense.

H. Proofrolling Subgrades:
1. Prior to placing fill or constructing pavements or slabs, proofroll the subgrade surface with sufficient proofrolling apparatus. Before starting proofrolling, submit to and obtain acceptance from Engineer of proofrolling apparatus and procedure to be used.
2. Proofrolling operations shall be made in the presence of Engineer. Notify Engineer at least 24 hours in advance of start of proofrolling operations.
3. Subgrades displaying pronounced elasticity or deformation, deflection, cracking, or rutting shall be stabilized as directed by Engineer. Unsuitable materials shall be undercut to the depth directed by Engineer and replaced with select fill material. Other suitable stabilization methods may be directed by Engineer.

I. Pipe Trench Preparation:
1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.
2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
   a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. Refer to Drawings for trench requirements. In no case should trench be wider at top of pipe than pipe barrel OD plus two feet, unless otherwise shown or indicated.
   b. Enlargement of trench width at pipe joints may be made when required and approved by Engineer.
   c. Trench width shall be sufficient for shoring and bracing, or shielding and dewatering.
   d. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.
   e. Do not use excavating equipment that requires the trench to be excavated to excessive width.
3. Depth of trench shall be as shown or indicated. If required and approved by Engineer in writing, depths may be revised.
4. Where Engineer considers existing material beneath bedding material unsuitable, remove and replace such unsuitable material with select fill material.

J. Excavated Materials to be Used as Fill:
1. Stockpile excavated materials that are acceptable for use as fill.
2. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
3. Place, grade, and shape stockpiles for proper drainage.
4. Locate and retain soil materials away from edge of excavations.
5. Dispose of excess soil material and waste materials as specified in this Section.
6. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials with the Contract Documents.

3.6 UNAUTHORIZED EXCAVATION:

A. All excavations outside lines and grades shown or indicated and that are not approved by Engineer, together with removing and disposing of the associated material, shall be at Contractor's

expense. Fill unautho¬rized excavations with properly-compacted select fill material at Contractor's expense.

3.7 EROSION AND SEDIMENT CONTROLS:

A. Provide temporary erosion and sediment controls in accordance with Section 01 5705, Temporary Controls. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction.

3.8 SHEETING, SHORING, AND BRACING:

A. General:
1. Design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work.
2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the Engineer's approval; but Contractor is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
3. Materials:
   a. Previously-used materials shall be in good condition, and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
   b. All steel work for sheeting, shoring, bracing, cofferdams and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
5. Comply with Laws and Regulations regarding sheeting, shoring, bracing, cofferdams, and similar excavation supports.
6. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time period excavations will be open.
7. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and Underground Facility, their appearance, and adjacent construction.

B. Sheeting Left in Place:
1. Materials: Steel sheeting shown or indicated to be left in place shall consist of rolled sections of continuous interlocking type. Steel sheeting material designated to be left in place shall be new. Type and design of the sheeting and bracing shall comply with the above requirements for steel work for all sheeting and bracing.
2. Installation:
   a. Steel sheeting to be left in place shall be driven straight to lines and grades as shown, indicated, or directed. Piles shall penetrate into firm materials with secure interlocking through¬out pile's entire length. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
   b. Type of guide structure used and method of driving steel sheeting to be left in place shall be determined by Contractor's professional engineer. Jetting is not allowed.
3. Cut off at elevations shown, indicated, or directed by Engineer sheeting left in place and remove cut off pilings from the Site.

4. Clean wales, braces, and all other items to be embedded in the permanent structure, and ensure that concrete surrounding the embedded element is sound and free of air pockets and harmful inclusions. Provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and welding of steel diaphragm waterstops perpendicular to the centerline of brace ends that are to be embedded.
5. Subsequent to removing the inside face forms, and when removal of bracing is allowed, cut back steel at least two inches inside the wall face and patch opening with concrete repair mortar in accordance with Section 03 3000, Cast-in-Place Concrete. Concrete shall be thoroughly worked beneath wales and braces, around stiffeners, and at other place where voids may be formed.
6. Portions of sheeting or soldier piles and breast boards that are in contact with structure foundation concrete shall be left in place, together with wales and bracing members that are cast into foundation or superstructure concrete.

C. Removal of Sheeting and Bracing:
1. Remove sheeting and bracing from excavations, unless otherwise directed by Engineer in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and Underground Facilities.
2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
   a. Concrete has cured for not less than seven days.
   b. Wall and floor framing, up to and including grade level floors, is in place.

3.9 TRENCH SHIELDS:

A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.

B. When using a shield for installing piping:
1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe's mid-diameter elevation prior to moving the shield along the trench for further construction.
2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.

C. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.

D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.10 FILL AND COMPACTION – GENERAL PROVISIONS:

A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.

B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
   1. Engineer's authorization after observation of construction below finish grade, including dampproofing, waterproofing, perimeter insulation, and similar Work.
   2. Inspection, testing, approval, and recording of locations of Underground Facilities.
   3. Removal of concrete formwork.
   4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
   5. Removal of trash and debris.
   6. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.
   7. Field testing of tanks, Underground Facilities including piping and conduits, and water-retaining structures.
   8. Placing of settlement plates.

C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.

D. Placement – General:
   1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
   2. Fill areas shall be undercut and proof-rolled as directed by Engineer.
   3. Place fill materials at moisture content and density as specified in Table 31 2305-A of this Section and this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.
   4. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 7,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and Underground Facilities. Effectiveness of the equipment selected by Contractor shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.
   5. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
   6. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material.

Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.

7. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, Contractor shall perform all work required to provide the required densities. Such work shall include, at no additional cost to Owner, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
8. Repair, at Contractor's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by Engineer.

E. Fill Against Concrete:
1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 3000, Cast-in-Place Concrete.
2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Electrical Ductbank Trenches:
1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
2. Placing and compacting fill in electrical ductbank trenches shall comply with requirements of Paragraph "G. Fill in Pipe Trenches", of this Article.

G. Fill in Pipe Trenches:
1. Place pipe bedding material in pipe trenches in horizontal layers, and thoroughly compact each layer before the next layer is placed.
2. Piping Installed in Fills Above Pre-construction Grade:
   a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
3. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
4. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
   a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
   b. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and

around each side of the pipe and back of the bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.

c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.

d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

H. Temporary Pavement:

1. Place 1.5 inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.

   Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

I. Subbase Placement:

1. Provide subbase material where shown to the limits shown or indicated.
2. Place subbase material in compacted lifts not exceeding depth of six inches each.

J. Drainage Fill Placement:

1. Provide drainage fill material where shown to the limits shown or indicated.
2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.

K. Compaction Density Requirements:

1. Compaction required for all types of fills shall be in accordance with Table 31 2305-A of this Section. Moisten material or aerate the material as necessary to provide the moisture content that will facilitate obtaining the required compaction.

TABLE 31 2305-A
REQUIRED MINIMUM DENSITY

Material	Percent Compaction (ASTM D698)	Uncompacted Lift (inches)
General Fill		
More than five feet below final grade	100	8
Less than five feet below final grade	95	8
Select Fill		
Below concrete slabs or mats	100	8
Below pavement and sidewalks	100	12
Behind concrete walls	95	8
Subbase Material		
Below pavement and sidewalks	100	12
All other locations	100	8
Pipe Bedding Material		
Below structures or pavement	100	8
All other locations	95	6
Drainage Fill	N/A	6

2. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
   a. On-site clayey soils: Optimum to plus three percent.
3. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated in Table 31 2305-A of this Section.
4. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3 of this Section.
5. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to Owner until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by Engineer) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

L. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with Table 31 23 05-A and the associated "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.11 GRADING:

A. General:
   1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.

2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:
1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below the required subgrade elevation.
3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

C. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten foot straight edge.

D. Compaction:
1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 CONTROLLED LOW STRENGTH MATERIAL (CLSM):

A. Controlled Low Strength Materials Placement:
1. Discharge CLSM from the mixer by reasonable means into the space to be filled.
2. Bring the fill material uniformly up to the fill line shown or indicated in the Contract Documents.
3. Placement of fill over the CLSM may proceed after a curing period of not less than three days.

3.13 PAVEMENT SUBBASE COURSE:

A. General:
1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
2. After completing filling and grading, shape and compact pavement subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by Engineer.

B. Grade Control:
1. During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Placing of Pavement Subbase Course:
1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.

2. Compaction and Grade Control: Comply with compaction requirements for excavation and fill in this Section, and the following requirements:
    a. Compaction with roller shall begin at the sides of the area to be paved and continue toward the center. Continue compaction until there is no movement of the course ahead of the roller.
    b. After compaction of top lift of pavement subbase, provide and uniformly spread pipe bedding material and screenings compacted, on the surface, and sweep using gang-dragged broom, followed by compaction.
    c. After rolling, check for grade with a line not less than 40 feet in length; depression over 1/2-inch deep shall be filled to satisfaction of Engineer.
3. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
4. Do not install pavement subbase in excess of 500 feet in length without compacting to prevent softening of the subgrade.
5. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material and replace with clean, compacted subbase material.

D. Shoulders:
1. Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each lift of subbase material.
2. Compact and roll not less than 12-inch width of shoulder simultaneously with compacting and rolling of each lift of subbase material.

3.14 DISPOSAL OF EXCAVATED MATERIALS:

A. General:
1. Contractor shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to Owner.

3.15 TEMPORARY BARRIERS:

A. Provide temporary barrier surrounding excavations and excavation work areas to provide temporary protection to persons and property. Barrier shall have openings only at vehicular, equipment, and worker access points.

B. Minimum Material Requirements for Temporary Barriers:
1. Temporary barrier shall not be less snow fence-type fencing, four feet high.
2. Fence shall be constructed of vertical hardwood slats measuring not less than 1.5 inches by 1/4 inch interwoven with strands of horizontal wire, or shall be of equivalent plastic construction.
3. Posts:
    a. Posts shall be steel, either “U”-, “Y”-, “T”-shaped, or channel section.
    b. Posts shall have a nominal weight of not less than 1/3-pound per linear foot, exclusive of the anchor.
    c. Posts shall have tapered anchors weighing not less than 0.67 pounds, each firmly attached by means of welding, riveting or clamping.
    d. Posts shall have corrugations, knobs, notches, or studs placed and constructed to engage a substantial number of fence line wire in the proper position.

e. Provide each post with sufficient quantity of galvanized wire fasteners or clamps, of not less than 0.120 inch diameter, for attaching fence wire to post.

3.16 FIELD QUALITY CONTROL:

A. Site Tests: Owner will employ a testing laboratory to perform field quality control testing. Payment for testing laboratory will be through the Materials Testing Allowance.
   1. Testing Laboratory Scope:
      a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
      b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
      c. Report results of each test to Engineer and Contractor.
   2. Required Material Tests:
      a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
   3. Authority and Duties of Testing Laboratory:
      a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to Engineer and Contractor. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of Engineer and Contractor to such failure.
      b. Technician will not act as foreman or perform other duties for Contractor. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate Engineer for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.
   4. Responsibilities and Duties of Contractor:
      a. Use of testing laboratory shall in no way relieve Contractor of the responsibility to provide materials and Work in full compliance with the Contract Documents.
      b. To facilitate testing laboratory, Contractor shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
      c. It shall be Contractor's responsibility to accomplish the specified compaction for fill and other earthwork. Contractor shall control construction operations by confirmation tests to verify and confirm that Contractor has complied, and is complying at all times, with the Contract Documents relative to compaction, control.
      d. Contractor shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.
         1) 200 linear feet of trench fill.
         2) 10 cubic yards of select fill.
         3) 100 cubic yards of general fill.
         4) 50 cubic yards of subbase material.
   5. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be taken as follows:
      a. Trenches for Structures, and Underground Facilities (including buried ductbanks):
         1) In Open Fields: Two locations every 1,000 linear feet.
         2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.

3) Crossing Paved Roads: Two locations along each crossing.
4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.

b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.

c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.

d. For General Fill: One per 1,000 square feet on every compacted lift.

e. Subbase Material: One per 1,000 square feet on every compacted lift.

6. Periodic compliance tests will be made by Engineer to verify that compaction is complying with the requirements specified, at no cost to Contractor. Contractor shall remove the overburden above the level at which Engineer wishes to test and shall fill and re-compact the excavation after testing is complete.

7. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade, fills, or bedding materials that did not originally comply with specified density shall be paid by Contractor.

END OF SECTION 31 2305

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SECTION 31 3700

RIPRAP

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals required to furnish and install riprap at locations shown or indicated in the Contract Documents.

B. Coordination:
1. Review procedures under this and other Sections and coordinate the Work that must be performed with or before riprap.

1.2 SUBMITTALS:

A. Acton Submittals: Submit the following:
1. Product Data:
a. Source or quarry name, gradation, and other information required by Engineer. Submit for each source of material proposed.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Where material is specified according to reference specification item number, submit copy of Supplier's valid certification from entity issuing the reference specification, and associated certification of material conformance with the reference specifications.

PART 2 – PRODUCTS

2.1 MATERIAL:

A. Riprap Type A: Material shall conform to Item 601.09 Type A, in accordance with the Ohio Department of Transportation Construction and Material Specifications.

B. Riprap Type B: Material shall conform to Item 601.09 Type B, in accordance with the Ohio Department of Transportation Construction and Material Specifications.

C. Riprap Type C: Material shall conform to Item 601.09 Type C, in accordance with the Ohio Department of Transportation Construction and Material Specifications.

PART 3 – EXECUTION

3.1 PREPARATION:

A. Clear ground surface of brush, trees, stumps, and other objectionable material, and dress to a smooth surface. Clearing and grubbing, where required, shall comply with Section 31 1100, Clearing and Grubbing.

B. Placing of geosynthetics, where required, shall comply with Section 31 0519.13, Geotextiles for Earthwork.

3.2 INSTALLATION:

A. Riprap Placing:
   1. Minimum total thickness of riprap shall be as shown on the Drawings.
   2. Exercise reasonable care to ensure that the finished surface of the protected channel conforms to the channel cross-section shown on the plans.
   3. Place riprap stones so that weight of stone is carried by underlying material and not by adjacent stones. Carefully place the stones on geosynthetics, where required, to produce an even distribution of pieces, with minimum of voids and without damaging the geosynthetic. Place the full-course thickness in one operation while preventing segregation and avoiding displacing of underlying material. Do not place stones in layers, by dumping into chutes, or by other methods that cause segregation or damage to geosynthetic, if any. When necessary, rearrange individual stones for uniform distribution.
   4. Riprap may be placed using equipment, and placing shall produce an installation of firm and solid riprap. Level the top surface of riprap to required alignment and slope by hand-placing stones to fill large voids and to make surface even.
   5. On slopes, place the largest stones at the bottom. Riprap shall be properly sized to form compact, solid blanket to protect the slope or channel, as applicable. On slopes steeper than one foot vertical to 1.5 feet horizontal, do not use rounded boulders or cobbles without grouting stones in place.
   6. When existing riprap is in proximity to riprap provided under this Section, place riprap to conform as closely as practicable in size and character to existing riprap.

END OF SECTION 31 3700

SECTION 32 0191

TREE PROTECTION AND TRIMMING

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and perform tree protection and trimming.
2. Extent of plantings to remain are shown. Extent of tree protection and trimming may include, but is not limited to, crown cleaning, crown thinning, crown raising, crown reduction, vista pruning and crown restoration; in addition to soil aeration, trench cut supervision and hand tunneling; drip line, root zone and tree trunk protection, and temporary barriers.
3. Types of products required include the following:
   a. Temporary protection barriers.
   b. Tree wound dressing.
   c. Drainage fill.
   d. Topsoil.
   e. Drain tile.
   f. Straw.
   g. Stone.
   h. Burlap.
   i. Accessories.

B. Coordination:
1. Review installation procedures under other Sections and coordinate construction activities and the installation of items that pass within the drip line, or that affect existing grade, in areas where existing plantings are to remain.

C. Related Sections:
1. Section 33 11 00, Clearing and Grubbing.
2. Section 31 23 05, Excavation and Fill.

1.2 REFERENCES:

A. Standards referenced in this Section are listed below:
1. American National Standards Institute, (ANSI).
   a. ANSI 300, Tree Care Operations - Tree, Shrub, and Other Woody Plant Maintenance - Standard Practices.
2. American Society for Testing and Materials, (ASTM).
   a. ASTM C 700, Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   b. ASTM D 448, Classification for Sizes of Aggregate for Road and Bridge Construction.
3. International Society of Arboriculture, (ISA).
   a. Trees and Building Sites.
   b. Tree-Pruning Guidelines.

1.3 QUALITY ASSURANCE:

A. Professional Arborist Qualifications:
   1. Engage an accredited professional arborist, acceptable to Engineer, skilled, trained and with successful and documented experience in the protection and restorative care of trees, certified by the International Society of Arboriculture or American Society of Consulting Arborists; who agrees to employ only tradesmen with specific skill and successful experience in this type of Work.
   2. Submit names and qualifications to Engineer along with the following information on a minimum of three successful projects.
      a. Names and telephone numbers of owner, architects or engineers responsible for projects.
      b. Approximate contract cost of the tree protection and trimming.
      c. Amount and kinds of tree protection and trimming performed.

B. Tree Pruning Standards: Comply with ANSI A300 and ISA standards, unless more stringent requirements are specified, or required by Site conditions.

C. Pre-installation Conference:
   1. Prior to commencement of Site construction Work, Contractor shall schedule and meet at the Site with professional arborist, installers of other Site construction Work in and around areas of existing plantings to remain, the Engineer and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to protection of existing plantings to remain, including the following:
      a. Review Project requirements and the Contract Documents.
      b. Review required submittals, both completed and yet to be completed.
      c. Review availability of materials and methods of delivery.
      d. Review location and types of below-grade work, required access during construction and methods of protection existing plantings.
      e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
      f. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
      g. Review procedures needed for protection of plantings during the remainder of the construction period.
      h. Review required inspection, testing, and certifying procedures.
   2. Record the discussions of the conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
   3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
   4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.4 SUBMITTALS:

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Submit product data for each material specified.

B. Informational Submittals: Submit the following:
   1. Certificates:

a. Certification by professional arborist that trees shown to remain were protected during the course of construction in accordance with recognized standards of the industry, as specified.
b. Certification that where damage did occur, trees were promptly and properly treated, or replaced.

2. Qualifications Data:
   a. Professional arborist.

C. Closeout Submittals: Submit the following:
1. Care and Maintenance Data:
   a. Submit typewritten instructions recommending procedures to be established by Owner for seasonal care and maintenance of trees affected by construction activities, after Substantial Completion.

1.5 PROJECT CONDITIONS:

A. Protection and Precautions:
1. Protect existing trees to remain during the course of construction in accordance with recognized standards of the industry, as specified.
2. Where damage occurs, professional arborist shall promptly and properly treat trees in accordance with recognized standards, as specified.
3. Replace damaged trees, as specified, at no additional cost to the Owner where, in the opinion of the professional arborist or Engineer, damaged trees are incapable of retaining full growth potential, or have been damaged to the extent that they can no longer perform their intended function in the landscape.

1.6 EXTENDED SERVICE:

A. Extended Landscape Service for Tree Repair and Replacement and Trees Affected by Grade Lowering:
1. Begin extended service immediately after each tree is acceptably planted or area regraded. Provide extended service for 90 days after tree plantings are acceptably completed and grade modifications performed.
2. Prune, cultivate, water, weed, fertilize, shade, mist, restore planting saucers, tighten and repair stakes and guy supports, and reset tree plantings to proper grades or vertical position, as required to establish healthy, viable plantings.
   a. Do not allow trees to wilt or show other signs of environmental stress. Visit the Site twice a week during the extended service periods, to inspect the condition of the plantings and immediately provide required care.
   b. Contractor shall provide landscape installer who shall be available on-call if notified between regular visits that plants require critical care or maintenance, throughout the time of extended service period.
3. Check and observe tree plantings for signs of insect and disease attack. Take corrective measures immediately upon notice of such attack. Control damaging insects and diseases, as specified.
4. Restore or replace damaged tree wrappings.
5. Remove dead trees immediately. Replace immediately unless required to plant in the succeeding planting season.

B. Provide sufficient water to ensure that tree root zone remains moist at all times.
1. Apply water using a 1-inch diameter hose with an attached metering gauge.

2. Apply water at a sufficiently slow rate to prevent water run-off from the soil surface but great enough to provide 0.2-inches of water per square foot of canopy area per hour for five hours each week.

C. Any decline in the condition of trees shall require Contractor to take immediate action to identify potential problems and undertake corrective measures. If required, engage professional arborist or horticulturist to inspect trees, identify problems and recommend corrective procedures. Advise Engineer of all such actions and submit inspection and recommendation reports.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Tree Wound Dressing: Provide tree wound dressing which is waterproof, adhesive and elastic with an antiseptic, free from kerosene, coal tar, creosote or any other material injurious to the life of the plant.

B. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D 448, Size 24, with 90 to 100 percent passing a 2-1/2-inch sieve and not more than ten percent passing a 3/4-inch sieve.

C. Topsoil: Provide topsoil, as required, that is fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth, free of any admixture of subsoil, clods of hard earth, plants or roots, sticks or other extraneous material harmful to the growth of plants. Obtain topsoil only from well-drained sites where soil occurs in depth of 4-inches or more; do not obtain from bogs or marshes. Supply topsoil with the following analysis:
1. 3/4-inch Mesh: 100 percent passing.
2. No. 4 Sieve: 90 to 100 percent passing.
3. No. 200 Sieve: 0 to 10 percent passing.
4. Clay content of material passing No. 200 sieve not greater than 60 percent, as determined by hydrometer tests.
5. pH 5.0 to pH 6.5. If approved by Engineer, natural topsoil not having the hydrogen-ion value specified may be amended by Contractor at his own expense.
6. Organic content not less than five percent, as determined by ignition loss.
7. Free of pests or pest larvae.

D. Drain Tile: Provide 4-inch standard strength, perforated bell-and- spigot clay pipe, in compliance with ASTM C 700.

E. Stone: Naturally occurring at the Site, as selected by Contractor.

F. Burlap: Jute not less than 7.2 ounces per square yard.

PART 3 - EXECUTION

3.1 PERFORMANCE:

A. General:
1. Install temporary fencing, barricades or guards, located as recommended by professional arborist, outside the drip line of trees.

2. Protect tree root systems from damage caused by noxious materials from run-off or spillage during mixing, placing, or storing of construction materials. Protect root systems from flooding, erosion or excessive wetting resulting from dewatering operations or other construction activities.
3. Do not allow fires under or adjacent to trees or other plants to remain.
4. Do not store materials, debris, topsoil or excavated subsoil within the drip line of trees to remain. Do not permit vehicles within drip line. Restrict foot, vehicle and equipment traffic to prevent compaction of soil over root systems. Where such activities are unavoidable, and only as acceptable to Engineer, provide continuous heavy wood planking, effectively fastened together and capable of distributing all loads from such activities, above a filter fabric layer covered with 2-inches of gravel.
5. Cut branches and roots, if required, with sharp pruning instruments; do not break or chop. Paint cuts over 1/2-inch in size with tree wound dressing.

B. Excavation:
1. Excavate within drip line of trees only where shown.
2. Where trenching for utilities is required within drip line, tunnel under or around main lateral feeder roots by drilling, auger boring, pipe jacking, or digging by hand under supervision of professional arborist. Do not cut main lateral roots or tap roots; cut smaller roots, which interfere with installation of the Work.
3. Where excavation for construction is required within drip line of trees, hand excavate to minimize damage to root systems. Perform excavation under supervision of professional arborist. Install shoring or other protective support systems at excavations, to minimize sloping or benching of excavations. Use narrow tine spading forks and comb soil to expose roots.
4. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of construction and relocation is not practical, cut roots approximately 3-inches back from construction.
5. Do not allow exposed roots to dry out before permanent backfill is placed; provide temporary earth cover. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.

C. Regrading:
1. Maintain existing grade within drip line of trees, unless otherwise shown or specified.
2. Grade Lowering:
    a. Where new finish grade is shown below existing grade around trees, slope grade beyond drip line. Maintain existing grade within the drip line of trees.
    b. Prune tree roots exposed during grade lowering, or provide permanent protections as recommended by professional arborist. Do not cut main or lateral roots or taproots; cut only smaller roots.
    c. Compensate for loss of roots and prune branches to stimulate root growth.
    d. Provide extended service during the Contract period as recommended by professional arborist.
3. Minor Fills:
    a. Where existing grade is 6-inches or less below elevation of finish grade shown, fill with topsoil.
    b. Place in single layer and do not compact.
    c. Hand grade to required finish elevations.

E. Tree Repair and Replacement:

1. Cavity Repair:
    a. Remove decayed areas to depth, which exposes healthy tissue.
    b. Shape cavities to provide drainage.
    c. Paint inside of cavity with accepted antiseptic tree wound paint.
    d. Do not fill cavities.
    e. When cavity cross section exceeds 60 percent of cross section of tree, remove tree upon authorization of Engineer.
    f. Remove tree stumps to 12-inches below finished grade.
2. Promptly repair trees damaged by construction operations within 24 hours of the occurrence of such damage. Treat damaged trunks, limbs, and roots according to written instructions of professional arborist.
3. Remove and replace dead trees, and damaged trees determined by professional arborist to be incapable of restoration to normal growth pattern.
4. If trees over 6-inches in caliper measurement, taken 12-inches above grade, are required to be replaced, provide new trees of 6-inch caliper size, and of the species selected by Engineer.

3.2 CLEAN-UP:

A. Burning of removed trees, chips and branches is not permitted on the Site.

B. Remove excess excavated material, displaced trees, excess chips and trimmings. Legally dispose off-Site.

C. Remove protection barriers and load distributing layers when no longer needed and restore areas beneath trees.

END OF SECTION 32 0191

SECTION 32 1200

FLEXIBLE PAVING

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install flexible, hot-mix, hot-laid, asphalt concrete pavement.
2. The Work includes:
a. Preparation such as sawcutting, milling where shown or indicated, cleaning, and other preparation for installing flexible pavements.
b. Providing asphalt concrete paving materials.
c. Providing tack coat material.
d. Providing pavement markings where shown or indicated.
e. Providing quality controls and testing.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before flexible paving Work.

C. Related Sections:
1. Section 31 2305, Excavation and Fill.
2. Section 32 1613, Concrete Curbs Gutters and Sidewalks.

1.2 REFERENCES:

A. Standards referenced in this Section are:
1. Construction and Materials Specifications of the State of Ohio Department of Transportation (ODOT), Latest Edition.

1.3 QUALITY ASSURANCE:

A. Standard Specifications and Details:
1. Contractor shall conform to all applicable requirements and testing of the State of Ohio Department of Transportation.

B. Qualifications:
1. Asphalt Concrete Production Facility:
a. Production facility for asphalt concrete, tack coat materials, and other bitumastic materials shall be certified by the Ohio Department of Transportationfor furnishing such materials for highways.
2. Contractor’s Testing Laboratory:
a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials provided under this Section.
b. Testing laboratory shall comply with ASTM E329.

c. Testing laboratory shall be experienced in the types of testing required.
d. Selection of testing laboratory is subject to Engineer's acceptance.

C. Regulatory Requirements:
1. Reference Specifications and Details:
a. Comply with applicable requirements of the Ohio Department of Transportation Construction and Material Specifications.
2. Obtain required highway and street rights-of-way work permits.

D. Quality Assurance Testing:
1. Quality assurance testing is in addition to source quality control testing, when required, and field quality control testing required under Article 3.4 of this Section.
2. Materials used in the Work may require testing and retesting, as directed by Engineer, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at Owner's expense, including retesting of rejected materials and installed Work, shall be performed at Contractor's expense.
3. Contractor's Quality Assurance Testing Laboratory Scope:
a. Use of testing laboratory shall not relieve Contractor of responsibility for providing materials and the Work in compliance with the Contract Documents.
b. Quality assurance testing laboratory shall perform the following, unless evidence of material compliance with reference specifications indicated in Paragraph 1.3.B of this Section , is submitted to Engineer by Contractor and asphalt concrete production facility:
1) Test in accordance with reference specifications indicated in Article 1.3 of this Section. In lieu of quality assurance testing, submit evidence and certification of material compliance with reference specifications. When evidence of conformance submitted is not acceptable to Engineer, perform quality assurance testing.
c. To facilitate testing services, Contractor shall:
1) Secure and deliver to testing laboratory and Engineer (when requested by Engineer) representative Samples of materials that Contractor proposes to furnish and that are required to be tested.
2) Furnish such labor as is necessary to obtain and handle Samples at the Site or at asphalt concrete production facility and other material sources.
3) Advise testing laboratory and Engineer sufficiently in advance of operations to allow for completion of quality assurance tests and for the assignment of personnel.

1.4 SUBMITTALS:

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Submit the proposed asphalt concrete mix design for each asphalt concrete material, and other bituminous materials, required under this Section, providing complete data on materials, including location in the Work, source, material content and percentages, temperatures and all other pertinent data. Indicate proportion of bituminous material from reclaimed asphalt pavement.
b. Proposed gradation for each aggregate to be used in flexible paving. Submit gradation test results for the same material furnished on a previous project. Indicate the proportion of reclaimed asphalt pavement.

c. In lieu of the information required under Paragraphs 1.4.A.1.a and 1.4.A.1.b, above, submit certificates of compliance with the reference specifications indicated in Article 1.3 of this Section, for each for the following:
1) Each mix design required.
2) Bituminous materials required.
3) Aggregates to be used in flexible paving, from each material source and each required gradation.
4) Density of uncompacted asphalt concrete material.
5) Density of previously-compacted, previously-tested asphalt concrete material.
6) Density and voids analysis for each asphalt concrete material test specimen.
7) Evidence of asphalt concrete plant inspection and compliance with the reference specifications indicated in Article 1.3 of this Section.
8) Proportion of reclaimed asphalt pavement in bituminous materials and aggregate.

2. Product Data:
a. Manufacturer's complete product data on all pavement marking materials proposed for use, including product literature, specifications, and recommended application techniques and other installation data.

B. Informational Submittals: Submit the following:
1. Quality Assurance Test Data Submittals and Source Quality Control Submittals:
a. Submit for quality assurance tests and source quality control tests required.
2. Field Quality Control Submittals:
a. Submit results of required field quality control testing.
3. Qualifications:
a. Asphalt concrete production facility, when required by Engineer.
b. Contractor's testing laboratory, when required by Engineer.

1.5 SITE CONDITIONS:

A. Weather Limitations:
1. Temperature:
a. For base course and binder course paving lifts equal to or greater than two inches thickness, atmospheric temperature shall be 40 degrees F and rising.
b. For surface course paving or other pavement courses in lifts less than two inches thick, temperature of surface on which pavement is to be placed shall be 50 degrees F or greater.
2. Prohibitions:
a. Do not place flexible paving materials when weather is foggy or during precipitation.
b. Do not place flexible paving materials when the base on which the material will be placed contains moisture in excess of optimum.
c. Place flexible paving materials only when Engineer concurs that weather conditions are suitable.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE:

A. System Description: as shown on the Drawings

2.2 ASPHALT CONCRETE MIXES:

A. Asphalt Concrete Mixtures: As shown on the Drawings

2.3 MATERIALS:

A. Materials for Asphalt Concrete: As shown on the Drawings

2.4 PAVEMENT MARKING MATERIALS:

A. Traffic and parking marking materials shall conform to ODOT Item 642.

B. Colors:
1. Roadway Center Markings Between Opposing Traffic Lanes: Yellow.
2. Roadway Side Striping: White, unless otherwise shown or specified. On roads with divided median, right-side striping of each direction shall be white, and left-side striping shall be yellow.
3. Roadway Miscellaneous Lane Markings (turn lane arrows and text): White.
4. Parking Spaces: White.
5. No-Parking Areas: White.
6. Handicap Parking Spaces: Unless otherwise indicated with signs, provide handicap symbol on pavement with blue paint.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Examine the subbase and base on which flexible paving will be installed. Notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Do not place materials on subgrades, or subbase that is muddy or has water thereon.

3.2 PREPARATION:

A. Preparation: Before starting installation of flexible paving, perform the following:
1. Grade Control: Establish and maintain throughout flexible paving installation the required lines and grades, including crown and cross slope for each asphalt concrete course during construction operations.
2. Prepare subgrade and provide subbase for flexible pavement in accordance with Section 31 2305, Excavation and Fill. Before installing flexible pavement, obtain Engineer's concurrence that subgrade and subbase are suitable for installing flexible pavement.
3. Coordinate placement of flexible pavement with the Work included under Section 32 1613, Concrete Curbs and Sidewalks, and Work including drainage structures, manholes, valve boxes, and similar items.
4. Provide appropriate maintenance and protection of traffic measures during placement of pavement.

B. Milling:
1. Perform milling of existing pavement where shown or indicated.

2. "Milling" consists of the milling, shaping, and removing portions of existing surfaces by cold milling process and subsequent cleaning.
3. Milling Equipment:
    a. Milling machines shall be power-operated, self-propelled machines capable of removing the desired thickness of existing surfaces. Machines shall have sufficient power, traction, and stability to accurately maintain depth of cut and slope. Machines shall produce a finished profile and cross slope to within 1/4 inch of that required and shall produce uniform surface texture free of gouges and ridges greater than 3/8-inch deep.
    b. Machines shall be equipped with a means to control dust and other particulate matter created by the cutting action.
    c. Provide equipment that removes milled material as quickly as the rate of milling.
    d. Use vacuum trucks, street sweepers or power brooms to clean milled surfaces.
4. Milling Operations:
    a. Perform milling to so that, when final course of pavement is placed, required elevations and grades are provided. Where required, establish a taut reference string line to control line and grade of milling.
    b. Minimize the time between milling and placement of pavement over milled surface.
    c. Areas not accessible to the milling machine, such as around or adjacent to drainage structures, manholes, curbs, and transverse joints on structures, may be removed by a small milling machine, handwork or other method acceptable to Engineer.
    d. Remove milled material as soon as it is milled. Remove fines and other material prior to opening milled area to traffic. Control objectionable dust emissions. When traffic has been allowed into milled area or when more than 48 hours have elapsed since milling, clean the milled area again prior to applying tack coat.
    e. Maintain drainage to drainage inlets and other drainage structures in a manner acceptable to Engineer.
    f. Properly dispose of milled material at a location away from the Site.

C. Surface Preparation:
1. Repair surface defects in existing pavement to provide uniform surface to receive new pavement.
2. Provide crack sealant to completely fill cracks more than 1/16-inch wide in areas shown or indicated on the Drawings.
3. Clean existing surfaces over which asphalt concrete pavement will be installed, by removing from the surface foreign material, excess asphalt concrete, excess joint sealant, and crack filler, and other undesirable matter.
4. Provide tack coat as indicated in Article 3.3 of this Section.

3.3 INSTALLATION OF FLEXIBLE PAVING:

A. General:
1. Provide final pavement surfaces of uniform texture, at required grades and cross-sections.
2. Construct roadways to the lines, grades, and typical sections shown or indicated.

B. Installation of Asphalt Concrete:
1. Asphalt concrete mixture shall be transported to the site of paving and placed as soon as possible after mixing.
2. Placement of each asphalt concrete course shall be completed over the full width of the section under construction during each day's paving operations.

3. Spread and finish asphalt concrete courses by means of self-propelled mechanical spreading and finishing equipment. Compacted thickness of layers placed shall not exceed 150 percent of specified thickness unless approved in writing by Engineer.
4. Compaction:
    a. Rollers:
        1) Use sufficient rolling equipment to satisfactorily compact and finish the quantity of asphalt concrete placed. There shall be not less than two rollers on the Project at all times. When acceptable to Engineer, one of the rollers may be a pneumatic-tire roller.
        2) During rolling operations, roller speed shall not exceed three miles per hour. When sufficient number of rollers is not available, reduce the quantity of asphalt concrete placed to accommodate the available rollers' speed.
        3) Required rollers shall be at the Site, in acceptable operating condition, prior to placing of asphalt concrete.
        4) Use of vibratory rollers in lieu of steel-wheeled rollers is acceptable, however when thickness of asphalt concrete is one-inch or less, rolling shall be in the static mode.
    b. Rolling of initially-placed asphalt concrete material, or breakdown rolling, shall begin as soon as the asphalt concrete mixture will bear the roller without undue displacement.
    c. Rolling shall be longitudinal, overlapping on successive trips by not less than one-half roller rear wheel width, and not more than three-quarters of roller rear wheel width. Alternate trips of the roller shall be of slightly different lengths.
    d. At all times, roller motion shall be slow enough to avoid displacing the asphalt concrete.
    e. Operate rollers continuously from breakdown of laid asphalt concrete through finish rolling.
    f. Perform finish rolling using a steel-wheeled roller or a vibratory steel-wheel roller operating in the static mode.
    g. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.
    h. At each location not accessible to roller, thoroughly compact asphalt concrete with tampers and finish, where necessary, with a hot smoothing iron to provide uniform, smooth layer over the entire area so compacted.
5. Each compacted asphalt concrete course shall be within plus or minus 1/4-inch of the indicated thickness.
6. Placement of Adjacent Strips of New Asphalt Concrete:
    a. When more than one width of asphalt concrete material will be placed, a six-inch wide strip of asphalt concrete adjacent to the area on which the future material is to be placed shall not be rolled until such future material is placed.
    b. Do not leave the unrolled strip unrolled for more than two hours after placement, unless the six-inch unrolled strip is first heated with a joint heater.
    c. After the first strip or width of asphalt concrete is compacted, place, finish, and compact the second width or strip as required for the first width, except that rolling shall be extended to include the six-inch strip of the first width not previously compacted.

C. Construction Joints:
1. Construction joints shall be made in such a manner as to ensure a neat junction, thorough compaction, and bond throughout.

2. Provide a transverse joint extending over the full width of the strip being laid and at right angles to its centerline at end of each workday and at other times when the placement of hot-mix asphalt concrete will be suspended for a period of time that will allow asphalt concrete mixture to chill.
3. Thoroughly compact by rolling the forward end of a freshly laid strip of asphalt concrete before the asphalt concrete mixture becomes chilled. When the Work is resumed, the end shall be cut vertically for the full depth of the layer.

D. Joining of Pavements:
1. When pavement is to join existing or previously-laid pavement, the existing or previously-laid pavement shall be neatly and carefully edged to allow for overlapping and feathering of the subsequent course of asphalt concrete material.
2. Where new pavement is to meet existing pavement, the existing pavement shall be sawcut and notched.
3. Where new pavement will meet existing asphalt pavement, remove existing pavement 12 inches onto undisturbed existing pavement course at edges where new pavement will meet existing pavement.
4. Tack Coat:
   a. Provide tack coat material at the following locations:
      1) At edges where new pavement will connect to existing or previously-installed pavement.
      2) On surface of existing or previously-installed pavement course over which new pavement will be installed, prior to placement of the subsequent pavement course. Tack coat may be deleted when a succeeding layer of asphalt pavement is being applied over a freshly-placed asphalt pavement course that has been subjected to very little or no traffic, with approval of Engineer
      3) Where new pavement will abut curbing, concrete gutters, drainage structures and frames, manhole cover frames, valve boxes, and similar items.
   b. Tack Coat Installation: Install tack coat immediately prior to installing pavement. Place pavement while tack coat is wet. Apply tack coat in accordance with reference specification indicated in Article 1.3 of this Section.

E. Curing:
1. Do not allow traffic onto pavement until directed by Engineer. Traffic will not be allowed on new asphalt concrete pavement until surface temperature is less than 140 degrees F.
2. Hold construction traffic on new pavement to a minimum as acceptable to Engineer.

F. Asphalt Concrete Curbs: Provide extruded asphalt curbs of the height and profile indicated on the Drawings.

G. Defective Pavement Work:
1. When directed by Engineer, remove and replace defective flexible paving Work. Cut out such areas of defective pavement and fill with fresh asphalt concrete materials, compacted to required density.

3.4 FIELD QUALITY CONTROL:

A. Site Tests:
1. Responsibility:
   a. Owner's field quality control testing laboratory will:

1) Perform field density tests to verify that required compaction of asphalt materials has been obtained.
2) Test the proposed materials for compliance with the Contract Documents, as directed by Engineer.
3) Submit reports of all test results to Engineer and Contractor.

b. Authority Field Quality Control Testing Laboratory:
1) Technicians representing the testing laboratory will inspect materials at the Site and perform required testing. When the materials furnished or Work performed do not comply with the Contract Documents, field quality control testing laboratory technician shall direct the attention of Engineer and Contractor to such non-compliance.
2) Testing laboratory personnel shall not act as foreman or perform other duties for Contractor. The Work will be checked as it progresses, but failure to detect defective Work shall not in any way prevent the later rejection of such defective Work when defect is discovered. Failure to detect defective Work as it occurs does not obligate Engineer to final acceptance. Testing laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, nor to approve or accept any portion of the Work.

2. Asphalt Concrete Mix Temperature: Measure temperature at time of placement, record, and submit to Engineer.
3. Surface Smoothness:
a. Test finished surface of each flexible paving course for smoothness, using a ten-foot straightedge applied parallel to and at right angles to centerline of paved areas.
b. Check surfaced areas at intervals as directed by Engineer.
c. Surfaces will be acceptable relative to smoothness when measurements are equal to or less than the following:
1) Base Course: 3/8-inch vertical in ten feet horizontal.
2) Binder Course: 3/8-inch vertical in ten feet horizontal.
3) Surface Course (Wearing Course): 1/4-inch vertical in ten feet horizontal.
4) Crowned Surfaces:
5) Test crowned surfaces with a crown template, centered and at right angles to the crown.
6) Surfaces will be acceptable when variance is equal to or less than 1/4-inch from the template.
d. Elevation: Finished surface of pavement shall be within plus or minus 1/2-inch of elevations shown or indicated.
4. Density:
a. Test Method: ASTM D2950 nuclear method ; test one sample every 1,000 square yards of pavement. Test for each asphalt concrete course installed.
b. In addition, when directed by Engineer, compare density of in place flexible paving materials against laboratory specimen or certificates on same asphalt pavement mixture, using nuclear density device.
c. Criteria for Acceptance: Density of in place asphalt pavement material shall be not less than 90 percent of the recorded laboratory specimen or certificate density. Density shall be not greater than 98 percent.
5. Repair holes from test specimens in accordance with this Section’s requirements for repairing defective Work.

3.5 ADJUSTING:

A. Frames and Covers:
   1. Set frames of drainage structures, manholes, valve boxes, and similar items to final grade. Adjust frames of existing structures and frames furnished under other Sections. Frames shall be substantially similar elevation to finished surface course of pavement.
   2. Replace covers and gratings of existing structures immediately following adjusting associated frames. Install covers and gratings of structures provided under the Project as quickly as possible.
   3. Where there is a delay between adjusting of frames and installation of surface course, provide temporary bituminous material around perimeter of each frame to smooth vehicle access over the frame. Maintain and repair temporary bituminous material as required until placement of surface course. Remove temporary bituminous material before installing surface course.

B. Pavement Adjustment:
   1. Repair or replace in manner acceptable to Engineer areas of pavement that are observed to pond or collect water.

3.6 CLEANING:

A. Cleaning: After completing the paving operations, clean surfaces of excess or spilled bituminous materials, excess asphalt concrete, and foreign matter.

3.7 PROTECTION:

A. Protect finished pavement until pavement has become properly hardened and cool.

B. Cover openings of drainage structures, manholes, valve boxes, and similar items in the paved area until permanent coverings are provided.

3.8 PAVEMENT MARKINGS:

A. Provide pavement markings at the locations shown or indicated, in accordance with ODOT Item 642.

END OF SECTION 32 1200

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SECTION 32 1613

CONCRETE CURBS AND SIDEWALKS

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete curbs and sidewalks.
2. Types of Work required under this Section include:
a. Conventionally-formed or machine-formed curb and sidewalk.
3. Width, thickness, geometry, and extent of curb and sidewalk shall be as shown or indicated on the Drawings.
4. Requirements for concrete sidewalks apply to concrete driveways, unless otherwise shown or specified, or unless concrete pavement requirements are included in the Contract Documents.

B. Related Sections:
1. Section 03 1100, Concrete Forming.
2. Section 03 1500, Concrete Accessories.
3. Section 03 2000, Concrete Reinforcing.
4. Section 03 3000, Cast-In-Place Concrete.
5. Section 07 9200, Joint Sealants.

1.2 QUALITY ASSURANCE:

A. Qualifications:
1. Installer:
a. Installer shall have not less than two years experience installing concrete curbs and sidewalks similar to those required for the Work.
b. When required by Engineer, submit record of experience documenting not less than three successful, completed projects. For each project, submit name the following information: project name, location of project, approximate quantity of concrete curb and sidewalk constructed by installer, contract price of concrete curb and sidewalk construction, and name and contact information for project owner and the project's construction-phase engineer.

1.3 SUBMITTALS:

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Submit concrete mix design when mix design is different from that submitted under Division 03 Sections on concrete. Submit in accordance with Division 03 Sections on concrete.
b. Proposed reinforcing materials.
c. Schedule of proposed underdrain piping sizes and materials by location in the Project.
2. Product Data:

a. Concrete Materials: Submit Supplier's technical information for materials proposed for use, when concrete materials are different from those submitted under Division 03 Sections on concrete.
b. Reinforcing Steel: Submit fabricator's technical information, including catalog information and specifications, for materials proposed for use, sufficient for Engineer to verify compliance with the Contract Documents.
c. Expansion Joint Filler: Submit Supplier's technical information, including manufacturer's product data, brochure, and specifications, for materials proposed for use, when materials are different from those submitted under Division 03 Sections on concrete.
d. Underdrain Piping: Manufacturer's product data, brochure, and specifications for underdrain piping proposed for use.

B. Informational Submittals: Submit the following:
1. Certifications:
a. When concrete materials are different from those approved under Division 03 Sections on concrete, submit certifications as required in concrete Specifications Sections referred to in this Section.
2. Site Quality Control Submittals:
a. Concrete test results for the Work included under this Section.
3. Qualifications Statements:
a. Installer, when requested by Engineer.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Division 03 Sections on concrete referenced in this Section.

1.5 SITE CONDITIONS:

A. Weather and Temperature Limitations:
1. When temperature and environmental conditions warrant, comply with requirements for cold weather placing and hot weather placing under Division 03 Sections referenced in this Section, unless otherwise required under this Section.
2. Temperature of aggregate base material under concrete shall be 39 degrees F or higher. Aggregate base material shall not have snow, ice, frost, or standing water on its surface at the time of concrete placing. Use of insulating materials and heating equipment may be required before concrete placing begins.
3. Discontinue concrete placing when the air temperature falls below 39 degrees F. Do not place concrete in the rain.

PART 2 – PRODUCTS

2.1 MATERIALS:

A. Aggregate Bedding Material for Curbs and Sidewalks: compacted Subbase Material in accordance with Section 31 2305, Excavation and Fill, unless otherwise shown or indicated.

B. Concrete Materials:
1. Comply with applicable requirements of: Section 03 1100, Concrete Forming; Section 03 1500, Concrete Accessories; Section 03 2000, Concrete Reinforcing; and Section 03 3000, Cast-in-Place Concrete; including requirements for formwork, concrete materials, admixtures, bonding materials, curing materials, and others as required.

2. Concrete Mix, Design, and Testing:
    a. Comply with applicable requirements of Section 03 3000, Cast-in-Place Concrete, for concrete mix design, sampling, and testing, and quality control.
    b. Design the mix to produce concrete of properties of compressive strength, slump range, and air content as specified in Section 03 3000, Cast-in-Place Concrete.
    c. When machine-formed equipment is used for constructing concrete curbs or sidewalks, concrete so placed shall have properties in accordance with Section 03 3000, Cast-in-Place Concrete, except that maximum slump shall be 2.5 inches and air content shall be two percent of design.

C. Reinforcing Materials:
1. Provide deformed steel bars and smooth wire fabric complying with Section 03 2000, Concrete Reinforcing.

D. Expansion Joint Material:
1. Preformed Expansion Joint Filler: Comply with Section 03 1500, Concrete Accessories, for preformed expansion joint fillers.
2. Joint Sealant: For joint sealants and accessories used on expansion joints, comply with Section 07 9200, Joint Sealants.

2.2 DETECTABLE WARNING PLATE:

A. Detectable warning plates shall consist of a surface of truncated domes and shall comply with the following:
1. Dome Size. Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inch (23 mm) minimum and 1.4 inches (36 mm) maximum, a top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and a height of 0.2 inch (5.1 mm).
2. Dome Spacing. Truncated domes in a detectable warning surface shall have a center-to center spacing of 1.6 inches (41 mm) minimum and 2.4 inches (61 mm) maximum, and a base-to base spacing of 0.65 inch (17 mm) minimum, measured between the most adjacent domes on a square grid.
3. Contrast. Detectable warning surfaces shall contrast visually with adjacent walking surfaces either light-on-dark, or dark-on-light.
4. Platform Edges. Detectable warning surfaces at platform boarding edges shall be 24 inches (610 mm) wide and shall extend the full length of the public use areas of the platform.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Examine subgrade, subbase, and conditions under which the Work is will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are been corrected.

B. Subgrade:
1. Verify that earthwork is completed to correct line and grade.
2. Verify that subgrade is smooth, properly compacted, and free of frost and excessive moisture in accordance with Division 31 Section on excavation and fill.
3. Do not commence the Work under this Section until conditions are satisfactory.

3.2 AGGREGATE BASE FOR CURBS AND SIDEWALKS:

A. Aggregate Base under Curb or Sidewalk:
   1. Install aggregate fill in accordance with Section 31 2305, Excavation and Fill. Properly compact aggregate fill to thickness shown or indicated in the Contract Documents.
   2. When thickness of aggregate base is not shown or indicated, provide six-inch thick aggregate base under curbs and sidewalks.

3.3 PERFORATED UNDERDRAIN PIPING:

A. Preparation for Underdrain Piping:
   1. Provide leveled and compacted bed of the required underdrain bedding material just prior to installing the underdrain piping. Slope bedding as shown and as required for drainage of underdrain piping.

B. Installation of Underdrain Piping:
   1. Install underdrain piping in accordance with pipe manufacturer's recommended installation procedures.
   2. Upgrade end of corrugated polyethylene underdrain pipe shall be closed with a solid plastic cap.
   3. Unless otherwise shown or required by Engineer, install underdrain pipe with perforations down.
   4. Install piping to drain to suitable discharge location.
   5. When polyethylene underdrains are daylighted through the side slope protect end of pipe from sunlight by providing section of corrugated steel or aluminum pipe, not less than three feet long, at the outlet. Extend the metal pipe not less than six inches into the ground and shall overlap the perforated underdrain piping by not less than the diameter of the underdrain pipe.

C. Acceptability of Underdrain Piping:
   1. With Engineer, visually inspect installed underdrain piping after installation and prior to filling and placing additional construction over underdrain piping. Piping will be acceptable when it is verified as installed on acceptable grade for drainage, is installed in accordance with the Contract Documents, and is free of damage and defects.

3.4 CONSTRUCTION OF FORMS:

A. Conventional Forms:
   1. Set forms to line and grade. Forms shall be free from warp.
   2. Install forms along full length of curb and sidewalk.
   3. Forms shall extend to the full depth of the curb and sidewalk (as applicable) and be secured so no displacement occurs during concrete placing.

B. At Contractor's option, machine-formed concrete curbs and sidewalks are acceptable.

3.5 REINFORCING:

A. General:
   1. Locate, place, and support reinforcing in accordance with Section 03 2000, Concrete Reinforcing, unless otherwise shown on the Drawings.
   2. Size of reinforcing shall be as shown or indicated in the Contract Documents.

3. Unless otherwise shown or indicated, locate reinforcing for sidewalks at the mid-depth point in the concrete slab.

B. When machine-formed concrete curbs and sidewalks are provided, reinforcing shall be suitable for the forming/placing method, at no additional cost to Owner. Obtain Engineer's approval of alternate reinforcing prior to placing concrete.

3.6 CONCRETE PLACING:

A. General:
1. Comply with Section 03 3000, Cast-in-Place Concrete, and this Section relative to mixing and placing concrete.

B. Placing:
1. Curbs: Place concrete using methods that prevent segregation of the mix. Consolidate concrete along face of forms with an internal vibrator.
2. Sidewalks: Place concrete in one-course, monolithic construction, for full width and depth of sidewalk.
3. Machine-Formed:
   a. At Contractor's option, automatic curb and sidewalk machine may be used for installing concrete.
   b. Machine forming shall produce curbs and sidewalks of required cross-section, lines, grades, finish, and jointing, as specified for conventionally-formed concrete.
   c. At curb cuts and driveway entrances, cut-out concrete and hand-finish the curbing to provide the required curb cut or driveway entrance, as applicable.
   d. If results do not comply with the Contract Documents, remove and replace at no additional cost to Owner.

C. Curbs:
1. Provide curb-cuts and driveway entrances for vehicle passage and pedestrian passage where shown, and when not shown but where existing sidewalks and curbs are being replaced, provide curb-cut or driveway entrance (as applicable) at location of existing driveways and pedestrian access ramps in sidewalks.
2. Neatly form transitions from curb to curb-cut or driveway entrance.
3. Unless otherwise shown or indicated, top of curb at curb-cut or driveway entrance shall be not greater than 1/4-inch above elevation of finished pavement surface.

3.7 JOINTS:

A. General:
1. Provide expansion joints, contraction joints, and construction joints in concrete curbs and sidewalks.
2. Provide expansion, contraction, and construction joints perpendicular to formed faces of curb or sidewalk.
3. Construct transverse joints at right angles to the Work centerline and as shown.

B. Contraction Joints: Provide joints as indicated below:
1. Curbs: Provide at intervals of ten feet on centers. Joint shall be not less than 1/8- inch and not more than 1/4-inch in width, and have a depth of 1.5 inches.
2. Sidewalks: Provide at intervals of five feet on centers. Joint shall be not less than 1/8- inch and not more than 1/4-inch in width, and have a depth of not less than one-third the total thickness of concrete sidewalk.

3. Joints may be formed or sawcut.

C. Construction Joints: Place construction joints at locations where concrete placing operations are stopped for more than 30 minutes, except where such pours terminate at expansion joints.

D. Expansion Joints:
1. General: Provide preformed expansion joint filler at locations indicated. When curb or sidewalk is not poured monolithically, provide expansion joints where each abuts the other.
2. Curbs: Provide 11/16-inch wide preformed expansion joint filter at the intervals of 30 feet along curb; at expansion joints in pavement; at movable structures (such as bridges); and between curb and: structures, returns, and at 30-foot intervals along length of curb.
3. Sidewalks: Provide 1/2-inch wide preformed expansion joint filler at 30-foot intervals along length of sidewalk and at all joints between sidewalk and: curb pavement, buildings, drainage structures, utility metal appurtenances such as manhole cover frames and valve boxes, and similar construction.
4. Place top of expansion joint material not less than 1/2-inch or more than one-inch below concrete surface. Apply joint sealer on top of expansion joint material flush with concrete surface, and in accordance with sealant manufacturer's instructions and Section 07 9200, Joint Sealants.

3.8 CONCRETE FINISHING:

A. Smooth exposed surface by screeding and floating. Perform hand-screeding when conventionally-formed concrete is provided.

B. Work edges of sidewalks, back top edge of curb, and transverse joints; and round to 1/4-inch radius.

C. Complete surface finishing by drawing a fine-hair broom across surface, perpendicular to line of traffic.

3.9 CURING:

A. General:
1. Protect and cure finished concrete curbs and sidewalks, in accordance with Section 03 3000, Cast-in-Place Concrete.
2. Cure driveways and sidewalks at driveways for not less than three days prior to opening to vehicle traffic. In colder weather, as indicated in Article 1.6 of this Section, curing period shall be not less than six days prior to opening to vehicle traffic unless other provisions to determine strength are provided and approved by Engineer.

3.10 REPAIR AND CLEANING:

A. Repair or replace broken or defective curbs and sidewalk as directed by Engineer.

B. Sweep the concrete curb and sidewalk Work and wash free of stains, discolorations, dirt, and other foreign material.

END OF SECTION 32 1613

SECTION 32 3100

FENCES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to furnish and install fencing.
2. Extent of fencing is shown or indicated.
3. Types of materials required under this Section include:
a. Aluminum-coated, steel chain link fabric.
b. Galvanized steel framework.
c. Polyvinylchloride fusion-bonded finish.
d. Gate operators and associated control systems.
e. Barbed wire.
f. Auxiliary system components, gates, accessories, fasteners, and fittings.
4. Substitutions: Structural shapes of satisfactory sections and equal strengths may be substituted upon Engineer's approval of Contractor's substitution request.

B. Related Sections:
1. Section 03 3000, Cast-In-Place Concrete.
2. Section 03 6000, Grouting.
3. Section 09 9100, Painting.

1.2 REFERENCES:

A. Standards referenced in this Section are:
1. ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. ASTM A90/A90M, Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A428/A428M, Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles.
6. ASTM A491, Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
7. ASTM A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
8. ASTM A817, Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric.
9. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
10. ASTM B6, Specification for Zinc.
11. ASTM D412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers—Tension.

12. ASTM D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
13. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
14. ASTM D1499, Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics.
15. ASTM D2240, Test Method for Rubber Property—Durometer Hardness.
16. ASTM F552, Terminology Relating to Chain Link Fencing.
17. ASTM F567, Practice for Installation of Chain-Link Fence.
18. ASTM F626, Specification for Fence Fittings.
19. ASTM A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
20. ASTM F668, Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
21. ASTM F900, Specification for Industrial and Commercial Swing Gates.
22. ASTM F1043, Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
23. ASTM F1083, Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
24. ASTM F1184, Specification for Industrial and Commercial Horizontal Slide Gates.
25. ASTM F1664, Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence.
26. ASTM F1665, Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used With Chain-Link Fence.
27. CLFMI CLF 2445, Product Manual.
28. CLFMI, Step-by-Step Installation Guide.
29. IEEE C2, National Electrical Safety Code.
30. IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements.
31. NEMA ICS 1, Industrial Control and Systems General Requirements.
32. NEMA ICS 2, Industrial Control and Systems: Controllers, Contactors and Overload Relays Rated 600 Volts.
33. NEMA ICS 6, Industrial Control and Systems Enclosures.
34. NEMA MG 1, Motors and Generators.
35. UL 467, Grounding and Bonding Equipment.

1.3 TERMINOLOGY:

A. The following words or terms are not defined but, when used in this Section, have the following meaning.
   1. “Knuckling” describes the type of selvage obtained by interlocking adjacent pairs of wire ends and then bending the wire ends back into a closed loop.
   2. “Gate operating cycle” is one gate opening plus one gate closing.
   3. “Fencing” describes an assembly of metal components, including wire chain-link fabric fastened to top, bottom and intermediate horizontal rails and to vertical line posts, corner posts and terminal posts. This assembly includes all auxiliary components, gates, fittings, fasteners, and other accessories, all with specified protective coatings.

B. Terminology used in this Section and not defined in this Article will be construed in accordance with the terminology used in CLF 2445 and ASTM F552.

1.4 QUALITY ASSURANCE:

A. Qualifications:
   1. Erector/Installer:
      a. Engage a single erector that is skilled and trained, and possesses successful and documented experience installing fencing, and employs only workers with specific skill and successful experience in the type of Work required.
      b. Erector shall be acceptable to fencing manufacturer,
      c. ubmit name and qualifications of erector with the following information for a minimum of three successful projects:
         1) Names and telephone numbers of owner and architect or engineer responsible for project.
         2) Approximate fencing contract amount.
         3) Quantity of fencing installed.

B. Component Supply and Compatibility:
   1. Provide fencing as complete system with all gates, hardware, appurtenances and other components produced by a single manufacturer, including custom erection accessories, fittings, clamps, and fastenings as required for complete system.
   2. Provide electrical components, devices and accessories from a single manufacturer regularly engaged in manufacturing such items, acceptable to, and coordinated by, fencing manufacturer.

C. Regulatory Requirements:
   1. Comply with Laws and Regulations, including:
      a. Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A of 28 CFR 36, Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. Electrical Components, Devices, and Accessories:
      a. Shall be listed and labeled by testing agency acceptable to authority having jurisdiction at the Site, and marked for intended use.
      b. Comply with requirements of authorities having jurisdiction at the Site for automatic gate operators serving as required means of access.

D. Mock-Ups:
   1. Build at the Site a ten-foot long, full-height mock-up that incorporates all fencing materials specified for the Work.
   2. Demonstrate to Engineer the ability to comply with quality of workmanship, methods of detailing, and tolerances shown or indicated. Upon approval, mock-up will serve as a standard for the fencing Work.
   3. Full size mock-ups that, in opinion of Engineer, do not adequately demonstrate erector's ability to comply with the Contract Documents will not be approved.
   4. Each combination of manufacturer and erector proposed by Contractor shall be allowed to build two full-size mock-ups using approved components for Engineer's approval of mock-up. If Engineer's approval is not obtained after two mock-ups, provide another combination of manufacturer and erector capable of complying with the Contract Documents at no additional cost to Owner.
   5. Do not alter, move, or destroy approved full-size mock-up until obtaining Engineer's written permission. Rebuild at no additional cost to Owner mock-ups destroyed before Contractor receives written permission.

6. Work advanced without an approved mock-up will not be eligible for payment until an approved mock-up is provided and Engineer has confirmed that Work already installed matches the approved mock-up.

1.5 SUBMITTALS:

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings at scale of 1/4-inch equal to one foot of typical fence assembly, identifying all materials, dimensions, sizes, weights, and finishes of rails, posts, braces, supports and other fencing components. Show fence heights, and locations of gates. Show gate swing, or other operation, hardware, and accessories. Include plans, elevations, and sections, with required installation and operating clearances, and details of post anchorage, attachments, and bracing.
      b. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
      c. Wiring Diagrams: Power and control wiring, communication, and access control features. Differentiate between manufacturer installed and Site installed wiring, and between components furnished by gate operator manufacturer and those by others.
      d. List of all hardware, fasteners, and accessories.
   2. Product Data:
      a. Copies of manufacturer's technical product information, and specifications for all fencing components, including auxiliary system components such as gate operators and motors.
      b. Data substantiating that materials proposed comply with the following:
         1) Physical properties of PVC protective coating, in compliance with ASTM D1499.
         2) Weight of aluminum coating on wire fabrications, in compliance with ASTM A428.
         3) Weight of zinc coating on pipe fabrications, in compliance with ASTM A90.
   3. Samples: Engineer's review will be for color and texture only. Compliance with other requirements is Contractor's responsibility. Submit the following:
      a. Each fencing component, fastener, post, rail, support, chain-link fabric type, and other auxiliary and miscellaneous items labeled with identification of proposed use and location.
      b. Sample of each chain-link fabric material, six inches square; and framework members, and typical accessories, each approximately six inches long.
      c. Full range of manufacturer's standard and custom color Samples.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Submit shipping list for materials used, endorsed with manufacturer's voucher, signed by authorized employee of manufacturer, certifying that material used in fencing complies with the Contract Documents and with the approved submittals.
      b. Certification that gate operators comply with requirements of authorities having jurisdiction at the Site for safety and emergency access.
      c. Certification that electrical components, devices, and accessories are listed and labeled by testing agency acceptable to authorities having jurisdiction at the Site, and are marked for intended use.
   2. Design Data: Submit with the Shop Drawings:

a. All structural calculations verifying that all system components comply with requirements of authorities having jurisdiction at the Site.
b. When proposing fencing framework or other structural components that varies from the Contract Documents, submit fabricator's structural calculations for design of proposed fencing. Structural analysis shall verify that all system components including supports, gates, fasteners, fittings, and connections comply with the Contract Documents and requirements of authorities having jurisdiction at the Site.

3. Manufacturer's Instructions:
   a. anufacturer's installation instructions.
4. Field Quality Control Submittals:
   a. Indicate and interpret test results for compliance of chain link fence and gate grounding and bonding with performance requirements specified in the Contract Documents.
5. Qualifications Statements:
   a. Erector.

C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data: Submit fencing system operations and maintenance manual in accordance with Section 01 7823, Operations and Maintenance Data, for the following:
   a. PVC finish.
   b. Motorized gate operators, including gate operating instructions and motor nameplate data, ratings, and other characteristics.
2. Warranty documentation.
3. Keys: Submit specified number of keys for locksets, padlocks, and control stations.

D. Maintenance Material Submittals: Submit the following:
1. Extra Stock Materials:
   a. Furnish extra stock materials from same manufactured lot as materials installed.
   b. Provide minimum of five percent excess over required amount of fencing components. Pack in cartons and store at the Site where directed by Owner.
   c. Do not provide partial containers or packages of materials. Round-up quantities to furnish only complete, unopened, and undamaged containers and packages.
   d. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used for this Project, with calculations substantiating quantity of extra stock materials furnished.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Delivery of Materials:
1. Packaging and Marking: Comply with CLFMI CLF 2445.
2. Deliver materials in manufacturer's original, unopened packaging with all factory-applied tags, labels and other identifying information intact, legible and accurately representing material on approved submittals.

B. Storage of Materials:
1. Store all materials under weatherproof cover, off the ground and away from other construction activities.
2. Do not store material in a manner that would create a humidity chamber. Provide for free movement of air under protective cover and between components of the fencing.

C. Handling of Materials:

1. Handle material in manner that is in compliance with manufacturer's recommendations and that avoids damaging coatings.

1.7 PROJECT CONDITIONS:

A. Existing Utilities: Do not interrupt utilities unless allowed:
   1. In Section 01 1416, Coordination with Owner's Operations; or
   2. Under the following conditions, only after providing temporary utility services according to requirements indicated.
      a. Notify Engineer and Owner not less than 7 days in advance of proposed utility interruptions.
      b. Do not proceed with utility interruptions without Engineer's written permission.

B. Obtain measurements at the Site to verify layout information and dimensions for fencing and gates in relation to reference points provided by Owner or indicated in the Contract Documents.

1.8 WARRANTY:

A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to and run concurrent with other warranties made by Contractor under the Contract Documents.

B. Special Warranties:
   1. Submit manufacturer's written ten-year warranty against cracking and peeling of PVC coating, and against rusting or corrosion of metal.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE:

A. Design Considerations:
   1. Verify size of framing members shown or indicated in the Contract Documents. Where structural analysis indicates the need, provide additional members, or increased member size, thickness or weight.
   2. Modifications may be made only as necessary to meet Site conditions to ensure proper fitting and support of the Work and only upon submittal of Shop Drawings and receipt of approval by Engineer.

2.2 MATERIALS

A. General:
   1. Tube sizes specified are nominal outside dimension.
   2. Roll formed section sizes are nominal outside dimensions.
   3. Wire gages shall conform to American Steel and Wire Company gage.
   4. Heat-form arcs and chords before applying protective coatings to metal.
   5. Sizes specified are given for uncoated metal. Protective coatings are in addition to specified metal dimensions, gages, and sizes.
   6. Provide weights of zinc and aluminum coatings on wire and pipe fabrications in accordance with CLFMI CLF 2445.

B. Chain-Link Fence Fabric:
   1. One-piece fabric widths, for fencing 12 feet and less in height, complying with CLFMI CLF 2445.
   2. Wire mesh shall be woven throughout in form of approximately-uniform square mesh with parallel sides and horizontal and vertical diagonals of approximately-uniform dimensions, of size and gage specified and in compliance with ASTM A817, Type 1, cold-drawn carbon steel wire with minimum breaking strength of 2,170 pounds and coated with aluminized finish, as specified. Fabric shall be as recommended by CLFMI for heavy industrial usage.
   3. Provide fence fabric imprinted with manufacturer's trade name, country of origin, core wire gage, and finished outside diameter gage.
   4. Provide fabric knuckled to eliminate exposure of sharp edges.
   5. Fabric Gage: Provide the following:
      a. No. 6-gage wires.
   6. Mesh Size: Provide the following:
      a. Two inch mesh.

2.3 FRAMEWORK:

A. General: The following table presents actual OD and equivalent nominal NPS size and trade size of round members:

Actual OD (inches)	NPS Size (inches)	Trade Size (inches)
1.315	1.0	1-3/8
1.660	1.25	1-5/8
1.900	1.5	2
2.375	2.0	2.5
2.875	2.5	3
3.500	3.0	3.5
4.000	3.5	4
6.625	6.0	6-5/8
8.625	8.0	8-5/8

B. Pipe shall be commercial grade, plain-end steel pipe with standard-weight walls. Steel strip used for manufacture of pipe shall comply with ASTM F1083, Schedule 40 pipe with minimum yield strength of 25,000 psi and protected with zinc, as specified.

C. Fittings: Comply with ASTM F626.

D. End, Corner, and Pull Posts: Provide end, corner, and pull posts of following minimum sizes:
   1. Up to six feet fabric height:
      a. 2.375 inches OD pipe weighing 3.65 pounds per linear foot.

E. Line Posts: Provide line posts of following minimum sizes and weights:
   1. Up to six feet fabric height:
      a. 1.90 inches OD pipe weighing 2.72 pounds per linear foot.

F. Gate Posts: Provide gate posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:
   1. Up to six feet wide:
      a. 2.875 inches OD pipe weighing 5.79 pounds per linear foot.
   2. Over six feet wide and up to 13 feet wide:

a. Four inches OD pipe weighing 9.11 pounds per linear foot.

3. Over 13 feet wide and up to 18 feet wide:
   a. 6.625 inches OD pipe weighing 18.97 pounds per linear foot.
4. Over 18 feet wide:
   a. 8.625 inches OD pipe weighing 28.55 pounds per linear foot.

G. Top Rail: Provide top rails, unless otherwise shown or indicated, conforming to the following:
1. 1.900 inch OD pipe weighing 2.72 pounds per linear foot.
2. Provide in manufacturer's longest lengths, with expansion-type coupling 0.051-inch thick rail sleeves, approximately seven inches long, for each joint.
3. Provide means for attaching top rail securely to each gate, corner, pull, and end post.

H. Center Rails Between Line Posts: Provide center rails between line posts, where shown, consisting of 1.660-inch OD pipe weighing 2.27 pounds per linear foot.

I. Roll-Formed Steel: Provide rolled steel shapes produced from structural-quality steel conforming to ASTM A1011, Grade 45, with minimum yield strength of 45,000 pounds psi. Protective coating system shall conform to ASTM F1043, as specified.

2.4 GATES:

A. Swing gates shall comply with ASTM F900.

B. Sliding gates shall comply with ASTM F1184.

C. Gate hinges shall be double clamping offset type. To hold gate in the open or closed positions, provide each gate frame with a keeper that automatically engages gate shoe set in concrete. Gates shall have drop latch with provision for padlock.
1. Gate Hinges: Pressed or forged steel or malleable iron to suit gate size, non-lift off type, 180-degree offset heavy-industrial hinges, 1.5 pair per leaf.
2. Latch: Forked-type or plunger bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
3. Keeper: Provide a gate keeper for vehicle gates that automatically engages gate leaf and holds gate leaf in open position until manually released.

D. Padlocks: Provide each gate with heavy-duty bronze padlock and shackle chain as follows:
1. Product and Manufacturer: Provide one of the following:
   a. No. 160DHM with 11/32-inch marine brass shackle by Master Lock Company.
   b. Or equal.
2. Provide three keys for each padlock. Where more than one gate is required for same enclosure, padlocks shall be keyed identically.

E. Provide gate frames with intermediate horizontal rails. Gate frames shall be welded construction and shall be galvanized after fabrication. Provide single gates six feet or greater in width, and double gates 12 feet or greater in width, with diagonal bracing in one direction, extending from top to bottom rail.

F. Fabricate gate perimeter frames of tubular members. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware, and accessories. Space so that frame members are not more than eight feet apart. Fabricate as follows:
1. Up to six feet high, or leaf width of eight feet or less:
   a. 1.660-inch OD pipe weighing 2.27 pounds per linear foot.

G. Assemble gate frames by welding or with special malleable or pressed steel fittings and rivets for rigid connections. Use same fabric as provided for fence. Install fabric with stretcher bars at vertical edges. Bars may also be used at top and bottom edges. Attach stretchers to gate frame at not more than 15 inches on centers. Attach hardware with rivets or by other means that will provide security against removal and breakage.

H. Install diagonal cross-bracing on gates consisting of 1/2 inch diameter adjustable length truss rods provided with turnbuckles to ensure frame rigidity without sag or twist.

I. Where barbed wire is shown or indicated above gates, extend end-members of gate frames one foot above top member and prepare to receive three strands of wire. Provide necessary clips for securing wire to extensions.

J. Sliding Gates: Provide manufacturer's heavy-duty track, ball bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, and accessories as required.

2.5 GATE OPERATORS:

A. General: Provide factory-assembled automatic gate operation system designed for gate size, type, weight, construction, use, traffic flow patterns, and operation frequency. Provide operation system for gate specified and shown, of size and capacity and with features, characteristics, and accessories suitable for Project conditions, recommended and provided by gate manufacturer complete with electric motor and factory prewired motor controls, remote control stations, control devices, power disconnect switch, obstruction detection device, lockable weatherproof enclosures protecting controls and all operating parts, and accessories required for proper operation. Provide enclosures with corrosion resistant protective and decorative finish and two keys per lock. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with Project electrical system.
   1. Provide operator constructed so motor may be removed without disturbing limit switch adjustment and without affecting auxiliary emergency operator.
   2. Provide operator in compliance with Laws and Regulations and requirements of authorities having jurisdiction at the Site.
   3. Provide electronic components with built-in troubleshooting diagnostic feature.
   4. Provide units designed and wired for both right-hand/left-hand opening, allowing universal installation.

B. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

C. Electromechanical Operation: Provide unit designed for concrete base/pad mounting; consisting of electric motor and factory prewired motor controls, starter, speed control device, brake, and clutch or torque limiter, with enclosed worm gear reducer, wheel and rail drive.

D. Operation Cycle Requirements: Provide gate operator designed to operate for not less than the following duty and cycles per hour.
   1. Heavy-Duty: 25 cycles per hour.

E. Gate Operation Speed:
   1. 60-feet per minute, minimum.

F. Electric Motors: High starting torque, reversible, continuous duty, insulated electric motors, complying with NEMA MG 1, sized to start and operate size and weight of gate in accordance

with Project's service conditions, without exceeding nameplate ratings or considering service factor.

1. Service Factor: In accordance with NEMA MG 1, unless otherwise indicated.
2. Enclosure: Totally enclosed, non-ventilated or fan-cooled motors, fitted with plugged drain.
3. Thermal Protection: Internal manual reset.
4. Motors 1/2 hp and Larger: single phase, 120 V, 60 Hertz.

G. Vehicle Presence Sensor: Provide complete system including automatic closing timer with adjustable time delay before closing and vehicle presence sensor designed to open and close gate and hold gate open until traffic clears. Vehicle presence sensor shall be model OVS-01GT, manufactured by Optex.

H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor causes operator to immediately function as follows:

1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
2. Internal Sensor: Built in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact pressure sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, located on gate as follows. Connect to control circuit using gate edge transmitter and operator receiver system.
    a. Along entire gate leaf trailing edge.
    b. Along entire length of gate posts.
    c. Along entire length of gate guide posts.
4. Photoelectric/Infrared Sensor System: Provide complete system constructed to detect obstruction in gate leaf path by interrupting an infrared beam in the zone pattern without allowing obstruction to contact gate.

I. Limit Switches: Provide adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

J. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type of mechanism, allowing manual operation if operator fails. Provide system configured such that control circuit power is disconnected during manual operation.

1. Type: Integral fail safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.

K. Operating Features: Include the following:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability of monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
2. Fully Systems Compatible: With controlling circuit board capable of accepting any type of input from external devices.
3. Automatic Closing Timer: Provide circuitry with adjustable time delay before closing and with timer cut off switch.
4. Open Override Circuit: Provide circuitry configured to override closing commands.
5. Reversal Time Delay: Provide time delay circuitry to protect gate system from shock load on reversal in both directions.
6. Maximum Run Timer: Configure circuitry to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
7. Clock Timer: Seven day programmable for regular events.

L. Accessories: Provide the following:
   1. Mounting kit, including pedestal.
   2. Audio Warning Module: Provide ADA compliant audible alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.
   3. Visual Warning Module: Provide ADA compliant visible light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.
   4. Battery Backup System: Battery powered drive and access control system, independent of primary drive system, opening gate if power fails.
   5. External electric powered lock with delay timer allowing time for lock to release before gate operates.
   6. Fire box.
   7. Fire Siren sensor.
   8. Instructional, Safety, and Warning Labels and Signs: Manufacturer's standard for components and features specified in compliance with authorities having jurisdiction at the Site.

2.6 AUXILIARY FENCING MATERIALS AND ACCESSORIES:

A. Wire Ties:
   1. For tying fabric to line posts, use nine-gage, aluminum alloy 1100-H4, PVC-coated wire ties to match fence fabric, spaced 12 inches on centers.
   2. For tying fabric to rails and braces, use nine-gage, aluminum alloy 1100-H4, PVC-coated wire ties to match fence fabric, spaced two feet on centers.
   3. For tying fabric to tension wire, use 11-gage, aluminum alloy 1100-H4, PVC-coated wire hog ring ties to match fence fabric, spaced two feet on centers.

B. Tension Wire: Provide tension wire consisting of aluminized, seven-gage, coiled spring steel wire coated with 0.40-ounces of aluminum per square foot of wire surface, minimum, in compliance with ASTM F1664.

C. Barbed Wire Supporting Arms: Pressed steel for three rows of barbed wire attached to each arm, complete with provisions for anchorage to posts. Supporting arms shall be integral with post-top weather cap. Provide following type:
   1. Single 45-degree arm, one for each post.

D. Post Caps: Pressed steel, wrought iron, or cast aluminum alloy, designed as weather-tight closure cap, for tubular posts. Provide one cap for each post unless equal protection is afforded by combination post-top cap and barbed wire supporting arm, where barbed wire is required.
   1. Provide caps with openings to allow through-passage of top rail.
   2. Provide cone-type caps for terminal posts and loop-type caps for line posts.

E. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross section of 3/16-inch by 3/4-inch. Provide one stretcher bar for each gate and end-post, and two for each corner- and pull-post, except where fabric is integrally woven into the post.

F. Stretcher Bar Bands: Pressed steel, galvanized, 0.078-inch to 0.108-inch thick depending on post diameter, spaced not greater than 15 inches on centers to secure stretcher bars to end-, corner-, pull-, and gate-posts.
   1. Bands may also be used with special fittings for securing rails to end-, corner-, pull-, and gate-posts.

G. Truss Rods: Steel rods, 3/8-inch diameter, merchant quality with turnbuckle.

H. Concrete: In accordance with Section 03 3000, Cast-In-Place Concrete.

2.7 FINISHING:

A. Chain-Link Fence Fabric:
1. Aluminized finish with not less than 0.40 ounces aluminum per square foot, complying with ASTM A491, Class II.

B. Framework and Appurtenances: Provide the following finishes for steel framework, auxiliary system components, and miscellaneous accessories:
1. Galvanizing: Zinc for galvanizing shall be of High Grade or Special High Grade conforming to ASTM B6 with maximum aluminum content of 0.01 percent. Galvanize metal using hot-dip process in accordance with the following:
a. Structural Iron and Steel Shapes: ASTM A123
b. Rolled-Form Sheet Steel: ASTM A653
c. Hardware and Accessories: ASTM A153
d. Fittings: ASTM F626
e. Pipe: ASTM A53
2. Provide minimum weights of zinc as follows:
a. Pipe: 1.8-ounces of zinc per square foot. Apply Type A coating both inside and outside according to ASTM F1043, as determined by ASTM A90.
b. Rolled-Form Sheet Steel: 4.0-ounces of zinc per square foot of surface area.
c. Hardware and Accessories: Zinc weights in compliance with Table 1 of ASTM A153.

C. Welded Joints:
1. Repair zinc coatings at welded joints by applying zinc-rich paint, as specified in Section 09 9100, Painting, and ASTM A780.
2. Repair polymer-coated steel by applying an epoxy primer, intermediate coat and urethane topcoat, as specified in Section 09 9100, Painting, matching color and reflectivity of adjacent PVC finish.

2.8 SOURCE QUALITY CONTROL:

A. Fabrication Tolerances:
1. Fabric, posts, rails, and other supports shall be straight or uniformly curved to provide the profiles shown, to dimensional tolerance of 1/16-inch in 10 feet without warp or rack in the finished Work.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Examine conditions under which the Work will be erected and notify Engineer in writing of conditions detrimental to proper and timely comple¬tion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 ERECTION:

A. Comply with CLFMI Step-by-Step Installation Guide and ASTM F567. Do not begin installation and erection of fencing until final grading is completed.

B. Excavation: Drill holes of diameters specified, for post footings in firm, undisturbed or compacted soil.
   1. For posts set in cast-in-place concrete, provide hole diameters dug or drilled a minimum of four times the largest cross section of post.
      a. Unless otherwise shown or indicated, excavate hole depths approximately three inches lower than bottom of post, with bottom of posts set not less than two feet below the surface of finished grade when in firm, undisturbed soil, plus an additional three inches for each foot increase in the fence height over four feet.
      b. Excavate holes for sliding cantilever gate-posts to not less than 3.5 feet below grade and minimum diameter of 12 inches.
   2. Spread soil from excavations uniformly adjacent to fence line, or on adjacent areas of the Site, as directed by Engineer.
   3. When solid rock is encountered at ground surface, drill into rock at least 12 inches for line-posts and at least 1.5 feet for end-, pull-, corner-, and gate-posts. Drill hole at least one inch greater diameter than largest dimension of post to be placed.
      a. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed the minimum depths specified above for rock encountered at ground surface.

C. Setting Posts: Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
   1. Center and align posts in holes 3-inches above bottom of excavation.
   2. Posts shall be set in concrete footings, except as otherwise shown or specified. Place concrete around posts in continuous pour, and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
   3. Extend concrete to two inches above ground surface, or to two inches below ground surface if cover of sod, bituminous asphalt paving, or other material is shown or indicated to conceal concrete. Crown to shed water away from posts.
   4. Extend footings for gate posts to underside of bottom hinge. Set keeps, stops, sleeves, and other accessories into concrete as required.
   5. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing materials, or other acceptable curing method.
   6. Grout posts set in sleeved holes, concrete constructions, or rock with grout, as specified in Section 03 6000, Grouting, and as recommended in CLFMI CLF 2445.

D. Concrete Strength: Allow concrete to attain at least 75 percent of its minimum 28 day compressive strength, but in no case sooner than seven days after placement, before installing rails, tension wires, barbed wire, or chain-link fabric.
   1. Do not stretch and tension fabric and wires, and do not hang gates, until concrete has attained its full design strength.

E. Posts and Rails:
   1. Line Posts: Set posts in cast-in-place concrete footings as specified, spaced not more than ten feet on centers. Provide caps on top of each post to exclude moisture and to receive top rail, unless equal protection is afforded by combination post-top cap and barbed wire supporting arm, where barbed wire is required.
   2. Top Rails: Run rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer to form continuous rail between terminal posts.

3. Center Rails: Provide center rails, where shown or specified, erected in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.
4. Brace Assemblies: Install braces so posts are plumb when diagonal rod are under proper tension. Install brace assemblies at end-posts and at both sides of corner- and pull-post panels. Panels adjacent to gates shall have intermediate horizontal rails and diagonal bracing. Diagonal bracing shall run from center of first line-post to bottom of terminal-post.

F. Chain-Link Fabric:
1. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released. Fasten to terminal posts and gate posts with tension bars threaded through mesh and secured with tension bands at maximum intervals of 14 inches.
2. Tie to line-posts, gate frames and top and bottom rails with tie wires spaced at maximum 12 inches on posts and two feet on rails.
3. Connect tension bars to posts and frames by means of adjustable bolts and bands spaced not more than 14 inches apart.
4. Leave approximately two inches between finish ground surface and bottom selvage, except where bottom of fabric extends into concrete.
5. Join roll of chain-link fabric by weaving a single picket into the ends of roll to form continuous mesh.

G. Tension Wire:
1. Stretch tension wire taut and free of sag, from end to end of each stretch of fence and position at a height that will enable the wire to be fastened to chain-link fabric by securing within the top 12 inches of chain-link fabric.
2. Fasten bottom tension wire within bottom six inches of chain-link fabric.
3. Tie tension wire to each post with not less than six-gage galvanized wire.

H. Barbed Wire:
1. Install three parallel wires on each extension arm; on security side of fence, unless otherwise shown or indicated
2. Pull wire taut to remove sag and firmly install in slots of extension arms to prevent movement or displacement.
3. Secure wire to terminal posts utilizing terminal post band arms or brace bands.
4. Extend vertical members of gates to receive barbed wire.

I. Stretcher Bars: Thread through or clamp to fabric four inches on centers, and secure to posts with metal bands spaced 15 inches on centers.

J. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground set items in concrete for anchorage, as shown on approved Shop Drawings. Adjust hardware for smooth operation and lubricate where necessary.

K. Gate Operators:
1. Mount and adjust operator on concrete pad.
2. Connect to gate and adjust for proper operation.
3. Refer to Division 26, Electrical, for electrical connections.

L. Tie Wires: Use U shaped wires conforming to diameter of pipe. Clasp pipe and fabric firmly with ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons and clothing.

M. Fasteners: Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.3 FIELD QUALITY CONTROL:

A. Site Tests:
1. Test and adjust automatic gate operators, controls, alarms, safety devices, hardware, limit switches, and other operable components. Replace damaged or malfunctioning operable components.
a. Energize circuits to electrical equipment and devices.
b. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test controls, alarms, and safeties.
2. Remove damaged and malfunctioning units, replace with new units, and retest.

B. Manufacturer's Services:
1. Engage a factory authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.
2. Train Owner's personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
3. Review data in maintenance manuals.
4. Provide minimum of two, 8-hour days of on-Site training during day shift normal working hours. Coordinate training schedule with Owner.

3.4 ADJUSTMENT AND CLEANING:

A. Repair coatings damaged in the shop or at the Site by recoating with manufacturer's recommended repair compound, applied in accordance with manufacturer's directions. Repair hot-dip galvanized coatings in accordance with ASTM A780.

B. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, and malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

C. Lubricate operating equipment and clean exposed surfaces.

D. Repair and replace broken or bent components.

END OF SECTION 32 3100

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SECTION 32 9200

TURF AND GRASS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all lawns and meadows.
2. Extent of lawns and meadows is shown.
3. Types of products required include the following.
a. Topsoil.
b. Lawn grass seed.
c. Meadow grass seed mixture.
d. Fertilizers.
e. Mulches.
f. Erosion-control materials.
g. Accessories.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, lawns and meadows.

C. Related Sections
1. Section 31 1100, Clearing and Grubbing
2. Section 32 9300, Plants

1.2 REFERENCES:

A. Standards referenced in this Section are listed below:
1. Association of Official Analytic Chemists, (AOAC).
a. Official Methods of Analysis of AOAC International.
2. Association of Official Seed Analysts, (AOSA).
a. Journal of Seed Technology; Rules for Testing Seeds.
3. American Society of Agronomy, (ASA).
a. Reference No. 1 - Methods of Soils Analysis, Soil Science Society of America, Incorporated.
4. American Society for Testing and Materials, (ASTM).
a. ASTM B 221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
b. ASTM C 602, Specification for Agricultural Liming Materials.
c. ASTM D 75, Practice for Sampling Aggregates.
d. ASTM D 422, Test Method for Particle Size Analysis of Soil.
e. ASTM D 977, Specification for Emulsified Asphalt.
f. fASTM D 2487, Practice for Classification of Soils for Engineering Purposes (United Soil Classification System).
g. ASTM D 5268, Specification for Topsoil Used for Landscape Purposes.

h. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
i. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

5. Turfgrass Producers International, (TPI).
   a. Guideline Specifications to Turfgrass Sodding.

1.3 DEFINITIONS

A. The term "finish grade" shall be used to describe the finished surface elevation of planting soil.

B. The term "manufactured topsoil" shall be used to describe soil produced off-Site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil acceptable as a component of loam.

C. The term "loam" shall be used to describe topsoil that has been mixed with additional organic and inorganic additives, as specified.

D. The term "percentage pure live seed" shall be defined as the percent (%) purity multiplied by percent (%) germination divided by 100 to equal the percent pure live seed (PLS) and shall be calculated for all seed lots using each seed lots own unique purity and germination test results. A PLS pound shall be defined as the bulk weight of seed required to equal one pound of 100 percent pure, germinated seed.

E. The term "subgrade" shall be used to describe the surface of subsoil remaining after completing excavation; or the top surface of a fill or backfill immediately beneath topsoil and which has not been tested for acceptable use as topsoil.

1.4 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Engage a single landscape installer skilled, trained and with successful and documented experience in the planting of lawns and meadows and with specific skill and successful experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualifications to Engineer along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owner, architects or engineers responsible for projects.
      b. Approximate contract cost of the lawns and meadows.
      c. Amount of area installed.
   2. Installer's Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-Site during the time of preparation for, and planting of, lawns and meadows. Supervisor shall have achieved landscape or horticultural certification acceptable to governing authorities having jurisdiction at the Site.
   3. Ratio of laborers to certified landscape supervisors shall not exceed 12 to one. Certified landscape supervisor shall be on-Site throughout the day-to-day performance of the Work of this Section.
   4. Application of herbicides, chemicals and insecticides shall be done by personnel licensed to perform such applications by governing authorities having jurisdiction at the Site and in accordance with each manufacturer's instructions provided on each product label.

B. Soil Testing Laboratory Qualifications:
   1. An independent laboratory, recognized by governing authorities having jurisdiction at the Site, with the experience and capability to conduct testing indicated and that specializes in types of soil tests to be performed.
   2. To qualify for approval, an independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work, in accordance with ASTM E 329 and as documented according to ASTM E 548.

C. Soil Analysis: Furnish report of soil analysis to Engineer, prepared by a qualified soil testing laboratory, stating percentages of organic matter; mechanical gradation of sand, silt, and clay content in compliance with ASTM D 422; cation exchange capacity; sodium absorption ratio; deleterious materials content; pH; and mineral and plant nutrient content of soil. Chemical analysis shall include tests for percentages of nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, iron, manganese, copper, zinc, extractable aluminum, and total soluble salts.
   1. Existing On-Site Soil:
      a. Separate soil stockpiled and proposed for use as topsoil for lawns and meadows into 1000 cubic yard piles and label with a numbering system used to reference all soil samples and test results.
      b. Obtain a one cubic foot representative sample for each 1000 cubic yards of soil stockpiled on-Site proposed for use as topsoil for lawns and meadows, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.
      c. Place samples taken from each stockpile, into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.
      d. Take one cup of soil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.
      e. Report suitability of soil as a topsoil component for lawn and meadow plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory topsoils. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of soil.
      f. In addition, all on-Site soil that will be used as topsoil shall be provided with additional compost and peat moss amendments specified, whether or not testing indicates positive need for such amendments, for such material to be used as loam.
   2. Manufactured Imported Topsoil:
      a. Test each 1000 cubic yards of manufactured topsoil at the proposed source. In addition, after Engineer's approval of manufactured topsoil based on results and recommendations of soil testing reports, test each 1000 cubic yards of manufactured topsoil that is delivered to the Site for conformance to results and recommended modifications of approved soil test reports. Manufactured topsoil that differs from proposed source material, after modification according to recommendations of soil test reports, shall be rejected for use in the Work.
      b. Obtain a one cubic foot representative sample for each 1000 cubic yards of manufactured topsoil proposed for lawn and meadow Work, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.
      c. Place samples taken from each stockpile into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of

each sample, taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.

d. Take one cup of topsoil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.

e. Report suitability of manufactured topsoil as a component for lawn and meadow plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory manufactured topsoil. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of manufactured topsoil.

f. Organic component of manufactured topsoil shall be obtained from compost and peat moss amendments specified, for such material to be used as loam.

D. Source Quality Control:

1. Analysis and Standards: Package all products with manufacturer's certified analysis performed in accordance with methods established by AOAC, wherever applicable, or as specified.
2. Provide manufactured imported topsoil from a commercial processing facility specializing in the manufacture of topsoil.
3. Seed that has been stored at temperatures, or under conditions not recommended by the seed supplier, or has become wet, moldy, or otherwise damaged, shall not be acceptable. The PLS for each seed lot shall be 75 percent, minimum.
4. Certify that all seed has been stored under conditions recommended by the seed supplier and has not been subjected to conditions damaging to PLS percentages.
5. Seed may be mixed by an approved method on-Site or at the seed supplier’s facilities. If the seed is mixed on-Site, each variety shall be delivered in the original containers and shall bear the supplier’s certified analysis. Where seed is mixed by the seed supplier, provide Engineer with the seed supplier’s certified statement as to the composition of the mixture.

1.5 SUBMITTALS:

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Schedule for lawn and meadow-planting showing anticipated planting dates for each type of Work.
2. Product Data:
   a. Manufacturer's product data, specifications and installation instructions for all required materials.
   b. Composition and analysis of commercial fertilizers and all purchase receipts showing the total quantity actually purchased for this Project.
   c. Proportions of each component contained in hydro seed mixture. Identify number of pounds of each component required for each 100 gallons of water. Include the number of square feet of lawn, grass meadow or wildflower meadow mixture that can be installed with each full tank of hydro seed mixture.
   d. PLS for each type of seed and each seed lot. Include bulk weight of seed required to equal one pound of 100 percent pure, germinated seed.

B. Informational Submittals: Submit the following:

1. Certificates:
    a. Certification of Grass and Wildflower Seed: For each grass-seed monostand and seed mixture, furnish seed supplier's certification stating the botanical and common name, and percentage by weight of each species and variety, and percentage of purity, germination and weed seed. Include the year of production and date of packaging. Certify that seed has been stored in compliance with all recommendations of the seed supplier.
    b. Certificates of inspection as may be required by governmental authorities to accompany shipments, and manufacturer's certified analysis for soil amendments and fertilizer materials. For standard products submit other data substantiating that materials comply with specified requirements.
2. Test Reports: Submit the following:
    a. Soil analysis reports for existing soil and imported manufactured topsoil, as specified. Include recommendations for remediating existing soil into acceptable topsoil.
3. Qualifications Data: Submit qualifications data for the following:
    a. Landscape installer.
    b. Landscape supervisor.
    c. Testing agency.
4. Source Quality Control Submittals
    a. Written statement providing the location from which manufactured topsoil is to be obtained and the names and addresses of the suppliers.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
    a. Submit recommended procedures to be established by Owner for the maintenance of lawns and meadows for one full year. Submit prior to expiration of required maintenance period.
2. Warranty Documentation:
    a. Submit written warranty, signed by Contractor and landscape installer, as specified.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Delivery of Materials:
1. Do not deliver seed until Site conditions are ready for installation.
2. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery.
3. Deliver seed in undamaged, original containers, sealed by the supplier and indicating compliance with approved Shop Drawings.
4. Inspect lawn and meadow materials upon arrival at Site. Immediately and permanently remove unacceptable materials from Site.

B. Storage of Materials:
1. Store and cover materials to prevent deterioration. Remove packaged materials that become wet or show deterioration or water marks from the Site.
2. Seed that becomes wet, moldy or damaged during the time of storage on-Site or that has been damaged during transit is not acceptable.

1.7 PROJECT CONDITIONS:

A. Environmental Requirements:
   1. Proceed with and complete lawn and meadow planting as rapidly as portions of the Site become available, working within the seasonal limitations for each type of lawn, grass and wildflower planting required.
   2. Proceed with planting only when current and forecasted weather conditions are favorable to successful planting and establishment of lawns and meadows.
      a. Do not spread seed when wind velocity exceeds five miles per hour.
      b. Do not plant when drought, or excessive moisture, or other unsatisfactory conditions prevail.
   3. Herbicides, chemicals and insecticides shall not be used on areas bordering wetlands.

B. Scheduling:
   1. Coordinate planting with specified extended service periods to provide required service from date of Substantial Completion. Plant during one of the following periods:
      a. Spring Planting: March 15 to June 1.
      b. Fall Planting: September 1 to October 30.
   2. Do not begin lawn and meadow planting until water, acceptable for use and adequate in supply, is available on-Site and can be successfully transported to the areas of Work. Coordinate provision of adequate and acceptable water supply with Project Schedule.
   3. Do not proceed with installation of loam until all subgrade utility services have been installed, are operating successfully and have been approved by Engineer.

C. Pre-installation Conference:
   1. Prior to commencement of lawn and meadow planting and associated Work, Contractor shall schedule and meet at the Site with the landscape installer, the installers of other Work in and around lawn and meadow areas that follows the lawn and meadow Work, including fencing Work specified in Section 32 3100, Fences; and Engineer and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the lawn and meadow Work, including the following:
      a. Review Project requirements and the Contract Documents.
      b. Review required submittals, both completed and yet to be com¬pleted.
      c. Review availability of water and methods of delivery.
      d. Review status of below-grade work and required access during lawn and meadow planting and establishment.
      e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
      f. Review environmental conditions, other Project conditions, and proce-dures for coping with unfavorable conditions.
      g. Review procedures required for protection of lawns and meadows during the remainder of the construction period.
      h. Review required inspection, testing, and certifying procedures.
   2. Record the discussions of the Pre-installation Conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
   3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
   4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.8 WARRANTY:

A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents.

B. Special Warranties: Warranty lawns and meadows through the specified extended service period.

1.9 EXTENDED SERVICE:

A. Extended Lawn Service:
   1. Begin extended service immediately after each lawn area is acceptably established. Provide extended service for not less than the following periods:
   2. Seeded Lawns: Sixty days from date after lawn areas are acceptably established.
      a. When full service period has not elapsed before end of planting season, or if lawn is not acceptably established, continue service during next planting season.
   3. Service lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
   4. Watering: Provide and maintain temporary piping, hoses, and lawn watering equipment to convey water from sources. Keep newly germinated plants uniformly moist to a depth of 4-inches, applied at a minimum rate of 1-inch per week, or greater as required to maintain minimum moisture depth specified. Provide and maintain watering gages and soil moisture probes until end of maintenance period.
      a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
      b. After plants have their first true leaves and grasses show mature blades, watering shall be performed to provide moisture to a depth of 6-inches, and not performed again until top 1-inch of loam has dried.
   5. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass-leaf height. Remove no more than 40 percent of grass leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain the following grass height:
      a. Mow grass 1 1/2 to 2-inches high.
   6. Lawn Fertilization: Apply fertilizer after initial mowing and when grass is dry.
      a. Use fertilizer that will provide actual nitrogen of at least one pound for each 1000 square feet of lawn area.
   7. After seed has passed its expected germination period, reseed all areas and parts of areas that fail to show a uniform stand of grass. Reseed repeatedly until all areas are covered with grass.

B. Extended Meadow Service:
   1. Begin extended service immediately after each meadow area is satisfactorily established and continue for not less than 40 days.
   2. Service meadow by watering, weeding, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch.

PART 2 – PRODUCTS:

2.1 MATERIALS:

A. Topsoil:
1. All soil accepted as topsoil, whether obtained from on-Site or off-Site sources, shall comply with specified topsoil analysis.
2. Provide fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth; free of any admixture of subsoil, clods of hard earth, plants or roots, sticks, stones larger than 1-inch in diameter, or other extraneous material harmful to plant growth, in compliance with ASTM D 5268. Provide topsoil with the following analysis:
   a. 3/4 inch mesh: 100 percent passing.
   b. No. 4-sieve: 90 to 100 percent passing.
   c. No. 200-sieve: 0 to 10 percent passing.
   d. Clay content of material passing No. 200-sieve not greater than 60 percent, as determined by hydrometer tests.
   e. pH-adjusted with ferrous sulphate or ground limestone to provide pH 5.5 to pH 7.0 at time of installation of lawns, grass and meadow areas, unless particular species of grass or wildflower stand requires a different pH to meet its growing needs.
   f. Electrical conductivity of a 1:2 soil-water suspension shall not exceed 1.0 milliohm per centimeter and with less than 200 parts per million of extractable aluminum.
   g. Cation Exchange Capacity: 5, minimum.
   h. Organic content not less than five percent, as determined by ignition loss of oven-dried samples passing No. 10-sieve (Muffle Furnace Temperature: 110 plus or minus five degrees C for eight hours).
   i. Free of pests and pest larvae.
3. Topsoil Source: Reuse surface soil stockpiled on Site, where possible. Verify suitability of stockpiled surface soil to produce topsoil, as specified. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
   a. Supplement acceptable on-Site soil with manufactured topsoil from off Site sources, when quantities available on-Site are insufficient to complete the Work.

B. Lawn Grass Seed:
1. Provide fresh, clean, new crop seed complying with the tolerance for purity and germination established by AOSA. Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, specified.
2. Seed Species: Seed of grass species as follows, with not less than 90 percent germination, not less than 80 percent pure seed, and not more than 0.25 percent weed seed by weight. Mixes shall be proportioned by weight as follows.
3. Type A
   a. 30% Kentucky Bluegrass (Poa pratensis).
   b. 30% Creeping Red Fescue (Festuca rubra).
   c. 20% Annual Ryegrass (Lolium multiflorum).
   d. 20% Perennial Ryegrass, turf type (Lolium perenne)
4. Type B
   a. 30% Kentucky Bluegrass (Poa pratensis)
   b. 40% Kentucky 31 Fescue (Festuca arundinacea var. KY 31 or Fawn Tall Fescue)
   c. 30% Perennial Ryegrass (Lolium perenne)

C. Ohio Flood Plain Seed:
   1. Provide a mixture of fresh, clean, new crop seed complying with the tolerance for purity and germination established by AOSA. Provide seed of each species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed specified.
   2. Provide Ohio Flood Plain Mix II by Ohio Prairie Nursery or equal.
   3. The seed shall be a mixture of grass, grasslike, and forb species. All species shall be native to Ohio and be suitable for periodic flooding and sun or partial shade.

D. Fertilizers:
   1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of four percent nitrogen and 20 percent phosphoric acid.
   2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
   3. Commercial Fertilizer: Commercial grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
      a. Composition: When applied, composition of fertilizer shall provide one pound of nitrogen per 1000 square feet; including four percent phosphorous, and two percent potassium, by weight.
   4. Slow Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water insoluble nitrogen, phosphorus, and potassium in the following composition:
      a. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
      b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil testing agency.

E. Mulches:
   1. Straw Mulch: Provide air dry, clean, mildew and certified seed free, salt hay or threshed straw of wheat, rye, oats, or barley.

F. Erosion-Control Materials:
   1. Erosion Control Blankets: 100 percent biodegradable wood excelsior, straw, or coconut fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended 6-inches long steel wire staples.
   2. Erosion Control Fiber Mesh: Biodegradable twisted jute or spun coir mesh, a minimum of 0.92 pounds per cubic yard, with 50 to 65 percent open area. Include manufacturer's recommended 6-inches long steel wire staples.

G. Accessories:
   1. Provide herbicides, chemicals and insecticides as needed for disease, fungus or pest control. All herbicides, chemicals and insecticides shall be bear approval labels indicating they are approved by the United States Department of Agriculture for the intended uses and application rates.
   2. Post Emergent Crab Grass and Plantain Chemical: Provide recommended post emergent crab grass and plantain control throughout the maintenance period to ensure germinated and established lawns free of crab grass and other undesirable grasses and forbs.

2.2 LOAM MIXES:

A. Follow recommendations of soil-testing laboratory for modifying on-Site soil and manufactured soil, for use as topsoil.

B. On-Site soil and manufactured soil that has been provided with all inorganic soil amendments and fertilizers recommended by soil-testing laboratory, and acceptable for use as topsoil, shall be mixed with an additional organic soil amendment mix in a ratio of two parts topsoil to one part organic soil amendment mix, by volume.
   1. Prepare soil amendment mix by combining 40 percent compost, 40 percent peat moss, ten percent wood derivatives, five percent well-rotted manure and five percent grit aggregate, by volume.

C. Loam: Thoroughly blend topsoil with organic soil amendment mix and use as planting media for all lawn and meadow Work.

PART 3 – EXECUTION:

3.1 INSPECTION:

A. Contractor shall examine the areas and conditions under which lawn and meadow Work is to be performed, and notify Engineer, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION:

A. Thoroughly blend and mix loam before spreading. Incorporate fertilizers, and ground limestone or acidulant, after spreading, as specified, and at rates recommended by soil-testing laboratory.

B. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroseeding overspray.

C. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties and walkways.

D. Perform percolation tests on existing subgrade and placed fills prior to fine grading.
   1. Perform percolation testing of subgrades and placed fills to determine whether or not the subgrade will drain properly. Perform percolation tests in accordance with the following procedure:
      a. Dig a hole in the subgrade that is 4-inches in diameter and 12-inches deep.
      b. Fill the hole with water and wait for the water to completely drain from the hole.
      c. Immediately refill the hole with water and measure the rate of fall in the water level.
   2. In the event that water drains at a rate less than 1-inch in one hour, excavate soil to a minimum depth of 24-inches, and deeper, as necessary to break the compaction. Backfill, recompact and retest each area so prepared to confirm drainage rates exceed one inch in one hour.
   3. Perform minimum of one soil percolation test for every 10,000 square feet of lawn and meadow area.

E. Excavate or fill subgrade, as required, to bring subgrade to elevations shown. Maintain all angles of repose. Confirm that subgrade is at proper elevations and that no further earthwork is required to bring the subgrade to proper elevations. Provide subgrade elevations that slope parallel to finished grade and towards subsurface drains shown.

F. Remove all construction debris, trash, rubble and all extraneous materials from subgrade. In the event that fuels, oils, concrete washout or other material harmful to plant growth or germination have been spilled into the subgrade, excavate the subgrade sufficiently to remove all such harmful materials and fill with approved fill, compacted to the required subgrade compaction level.

3.3 FINE GRADING:

A. Immediately prior to dumping and spreading loam, clean subgrade of all stones greater than 2-inches and all other extraneous matter. Remove all such material from Site. Notify Engineer that subgrade has been cleaned, and obtain approval prior to spreading loam.

B. Do not attempt to spread excessively wet, muddy or frozen loam. Do not spread loam more than five days before seeding or planting.

C. Spread loam to a depth of 8 inches but not less than required to meet finish grades after light rolling and natural settlement.
   1. Spread approximately one-half the thickness of required loam depth. After spreading loam, rototill, disk or harrow loam and subgrade to bring top 2-inches of subgrade upward into loam layer, so that there is a transitional layer between loam and subgrade.
   2. Spread remainder of loam to required finish grades.
   3. Compact each lift sufficiently to reduce settling, but not enough to prevent the movement of water and feeder roots through loam. After compaction spread loam should offer firm, even resistance when a soil sampling tube is inserted.
   4. Phase the placement of the final lift so that wheeled vehicles do not have to travel over areas where final lifts are already in-place.
   5. Spread and compact to a smooth, uniform surface plane, to within plus or minus 1/2-inch of finish elevations. Roll and rake and remove all ridges, and fill depressions, as required. Remove all stones larger than 1-inch in any dimension and all sticks, roots, trash and other extraneous matter.
   6. Perform percolation tests as for subgrades, except limit depth of holes to 2/3 the depth of loam layer.

D. Spread ground limestone or acidulant and fertilizer, as specified. Mix ground limestone with dry loam before spreading fertilizer and work lightly into the top 4-inches of loam by harrowing or tilling at least three days before applying commercial fertilizers.

E. Grade planting areas to smooth, even surface with loose, uniformly fine texture. Remove all stones and extraneous material in excess of 1 inch diameter. Roll, rake and remove ridges and fill depressions, as required to meet finish grades.

F. Moisten prepared areas before seeding, sodding, sprigging or plugging. Water thoroughly and allow surface moisture to dry before planting. Do not create a muddy loam condition.

G. Prior to seeding or planting, restore loam to specified condition, if eroded or otherwise disturbed.

3.4 CONVENTIONAL SEEDING:

A. General: Maintain grade stakes until removal is mutually agreed upon by all parties concerned.

B. Rake or harrow all seedbeds immediately prior to seeding to produce a rough, grooved surface, no deeper than 1-inch. Seed only when seedbed is in a friable condition and not muddy or hard.

C. Sow seed using a spreader or seeding machine.

D. Distribute seed evenly over entire area by sowing equal quantity in two directions at right angles to each other.

E. Sow lawn grass seed mixture at the rate of not less than eight-pounds for every 1000 square feet.

F. Sow meadow grass with minor forbs seed mixture at the rate of not less than 38-pounds per acre.

G. Cultipacker, or approved similar equipment, may be used to cover the seed and to firm the seedbed in one operation. In areas inaccessible to cultipacker:
   1. Rake the seed lightly into top 1/8-inch of loam, roll in two directions with a water ballast roller, weighing not less than 100 pounds per linear foot.
   2. Take care during raking that seed is not raked from one spot to another.
   3. Protect seeded areas against erosion by spreading specified mulch after completion of seeding operations.
      a. Protect seeded areas against hot, dry weather or drying winds by applying peat moss mulch not more than 24 hours after completion of seeding operations. Presoak and scatter evenly to a depth of from 1/8 inch to 3/16 inches thick and roll to a smooth surface. Do not mound.
      b. Spread straw mulch to form a continuous loose blanket not less than 1 1/2 inch deep over seeded areas at the approximately rate of two tons-per acre.
         1) Anchor mulch by spraying with asphalt emulsion at the rate of ten to 13-gallons per 1000 square feet.
         2) Place mulch with equipment that will blow or eject, by means of a constant air stream, controlled quantities of the mulch and asphalt in a uniform pattern over the specified area. If the mulch is excessively cut or broken, take measures to reduce the cutting or breakage. Introduce the asphalt into the air stream by means of a spray arranged so that it will partially coat the mulch with a spotty asphalt tack prior to the depositing of the mulch covering. Rate of application not less than 75-gallons per ton of mulch.
      c. Protect seeded areas, with slopes exceeding one on six, by providing erosion-control fiber mesh and where slopes exceed one on four, by providing erosion-control blankets. Install erosion-control materials according to manufacturer's written instructions and as follows:
         1) Vertically down slope without stretching fabric.
         2) Install hold down staples three per square yard minimum in center of fabric or as required to hold and shape the fabric to the contours of the slope. Install hold down staples along edges and overlaps of fabric at 9 inches on centers minimum, or as required to hold and shape the fabric to the contours of the slope.
         3) Lap fabric 4-inches minimum and turn edges of fabric into 8-inch deep by 16-inch wide earth trench and fill trench with earth.

H. Using a uniform fine spray, thoroughly and evenly water seeded areas. Provide adequate water to moisten seedbed to a depth of 2-inches.
   1. Repeat this process when peat mulch color lightens. Maintain all seedbeds in a uniformly moist condition, conducive to seed germination and plant establishment, as specified.

I. Reseed areas that remain without mulch for longer than three days.

J. Take precautions to prevent damage or staining of construction or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

K. Prevent foot or vehicular traffic, or the movement of equipment, over the mulched areas. Reseed areas damaged as a result of such activity.

3.5 HYDROSEEDING:

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

B. Mix slurry with asphalt emulsion tackifier.

C. Apply slurry uniformly to all areas to be seeded in a two step process. Apply first slurry application at a minimum rate of 500 pounds per acre dry weight, but not less than the rate required to obtain specified seed sowing rate so that the seed comes into direct contact with loam.

D. Apply slurry cover coat of fiber mulch at a rate of 1000-pounds per acre.

3.6 RECONDITIONING EXISTING LAWNS AND MEADOWS:

A. Recondition existing lawn and meadow damaged by Contractor's operations, including areas used for storage of materials or equipment and areas damaged by movement of vehicles. Recondition existing lawns and meadow areas where minor regrading is required.

B. Recondition other existing lawn and meadow areas shown.

C. Provide fertilizer, seed or sod and soil amendments, as specified for new lawn and meadow, and as required to provide satisfactorily reconditioned lawns and meadows. Provide new loam as required to fill low spots and meet new finish grades.

D. Till stripped, bare, and compacted areas thoroughly to a depth of 12-inches.

E. Remove diseased or unsatisfactory lawn and meadow areas; do not bury into soil. Remove topsoil containing extraneous materials resulting from Contractor's operations including oil drippings, stone, gravel and other construction materials.

F. In areas approved by Engineer, where substantial lawns and meadows remain (but are thin), mow, dethatch, core aerate and rake. Fill low spots, remove humps, cultivate soil, fertilize, and seed. Remove weeds before seeding or if extensive, apply selective chemical weed killers, as required. Apply a seedbed mulch, if required, to maintain moist condition.

G. Water newly planted areas and keep moist until new lawns and meadows are established, as specified.

3.7 ACCEPTANCE CRITERIA FOR LAWNS AND MEADOWS:

A. Lawn and meadow Work will be considered acceptable when:
   1. Seeded Lawn: When a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 square feet and bare spots not exceeding 5-inches by 5-inches.
   2. Seeded Meadow: When a healthy, uniform, close stand of meadow grass and forbs has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 20 square feet and bare spots not exceeding 12-inches by 12-inches.

3.8 CLEANUP AND PROTECTION:

A. Promptly remove soil and debris, created by lawn and meadow Work, from paved areas. Clean wheels of vehicles before leaving Site to avoid tracking soil and loam onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout extended service period and remove when service period ends. Treat, repair or replace damaged lawns and meadows.

C. Remove erosion control measures after lawn and meadow extended service period ends.

D. Take all precautions to ensure that hydroseed slurry is only placed on the areas designated. Completely clean any overspray, on areas not designated to receive slurry.

3.9 INSPECTION AND ACCEPTANCE:

A. Where lawns and meadows do not comply with specified acceptance criteria, reestablish lawns and meadows and continue extended service period until lawns and meadows comply with criteria for acceptance.

3.10 DEMONSTRATION:

A. Engage installer’s Site supervisor to train and instruct Owner’s personnel in the proper maintenance of lawns and meadows and procedures to be performed throughout the year for proper care and maintenance of lawn and meadows.
   1. Include instructions and training on reconditioning established lawns and meadow and sources of lawn and meadow materials.
   2. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

B. Review Operation and Maintenance information and be sure all instructions are clearly understood by Owner’s personnel and are supplemented with additional information, clarifications and instructions, as required.

C. Provide minimum of two, nonconsecutive, full days on-Site training time during day shift normal working hours.

END OF SECTION 32 9200

SECTION 32 9300

PLANTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install plants.
   2. Extent of plants is shown.
   3. Types of products required include the following.
      a. Shade and flowering trees.
      b. Deciduous shrubs.
      c. Organic topsoil amendments.
      d. Topsoil
      e. Fertilizers.
      f. Mulches and weed-control barriers.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the plants.

C. Related Sections:
   1. Section 33 1100, Clearing and Grubbing.
   2. Section 32 9200, Turf and Grass.
   3. Section 32 0191, Tree Protection and Trimming.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
      a. ANSI Z60.1, American Standard for Nursery Stock.
   2. Association of Official Analytic Chemists, (AOAC).
      a. Official Methods of Analysis of AOAC International.
   3. American Society of Agronomy, (ASA).
      a. Reference No. 1 - Methods of Soils Analysis, Soil Science Society of America, Incorporated.
   4. American Society for Testing and Materials, (ASTM).
      a. ASTM A 36, Specification for Carbon Structural Steel.
      b. ASTM A 641, Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
      c. ASTM D 75, Practice for Sampling Aggregates.
      d. ASTM D 422, Test Method for Particle Size Analysis of Soil.
      e. ASTM D 977, Specification for Emulsified Asphalt.
      f. ASTM D 2487, Practice for Classification of Soils for Engineering Purposes (United Soil Classification System).
      g. ASTM D 4397, Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications.
      h. ASTM D 5268, Specification for Topsoil Used for Landscape Purposes.

i. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
j. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

5. Hortus III, Liberty Hyde Bailey Hortorium.
6. The Rainforest Alliance, SmartWood Certified Forestry Program.
7. United States Department of Agriculture, (USDA).
   a. Description of the Eco-regions of the United States.
   b. Plant Hardiness Zone Maps.

1.3 DEFINITIONS

A. The term “balled and burlapped stock” describes plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. The term “balled and potted stock” describes plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

C. The term “bare-root stock” describes plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for kind and size of plant required.

D. The term “container-grown stock” describes healthy, vigorous, well-rooted plants, grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of plant required.

E. The term “fabric bag-grown stock” describes healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

F. The term “finish grade” describes elevation of finished surface of planting soil mix.

G. The term “manufactured topsoil” describes soil produced off-Site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil for planting soil mix.

H. The term “planting soil mix” describes native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with topsoil amendments.

I. The term “subgrade” describes surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil mix.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage a single landscape installer skilled, trained and with successful and documented experience in the planting of plants and in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualifications to Engineer along with the following information on a minimum of three successful projects:
    a. Names and telephone numbers of owner, architects or engineers responsible for projects.
    b. Approximate contract cost of the plants.
    c. Amount and kinds of plants installed.
2. Installer's Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-Site during the time of preparation for, and planting of, plants. Supervisor shall have achieved landscape or horticultural certification acceptable to governing authorities having jurisdiction at the Site.
3. Ratio of laborers to certified landscape supervisors shall not exceed 12 to one. Certified landscape supervisor shall be on-Site throughout the day-to-day performance of the Work of this Section.
4. Application of herbicides, chemicals and insecticides shall be done by personnel licensed to perform such applications by governing authorities having jurisdiction at the Site and in accordance with each manufacturer's instructions provided on each product label.

B. Soil-Testing Laboratory Qualifications:
1. An independent laboratory, recognized by governing authorities having jurisdiction at the Site, with the experience and capability to conduct testing indicated and that specializes in types of soil tests to be performed.
2. To qualify for approval, an independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E 329 and as documented according to ASTM E 548, without delaying the Work.

C. Source Quality Control:
1. General:
    a. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements of ANSI Z60.1.
    b. Ship plants with certificates of inspection as required by governing authorities having jurisdiction at the Site.
2. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the AOAC, wherever applicable or specified.
3. Provide plants grown in a recognized nursery in accordance with good horticultural practice, with healthy root systems developed by transplanting or root pruning. Provide healthy, vigorous plants grown for at least two years under climatic conditions similar to conditions in the locality of the Project and free of disease, insects, eggs, larvae, and defects such as knots, sun-scald, injuries, abrasions or disfigurement.
    a. Provide plants of the sizes shown. Plants of larger size may be used if acceptable to Engineer, and if sizes of roots or balls are increased proportionately.
    b. Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6-inches above ground for trees up to 4-inch caliper size, and 12-inches above ground for larger sizes.
    c. Measure main body of tree or shrub for height and spread; do not measure branches, or roots, tip-to-tip.

4. Plants showing signs of graft incompatibility shall be removed from the Site. Visual indication of graft incompatibility shall include:
    a. Development of over-growths by rootstock or scion resulting in the development of shoulders or inverted shoulders.
    b. Suckering of the rootstock combined with poor growth or dieback of the scion.
    c. Any mechanical weakness between scion and rootstock.
    d. Any marked difference in bark pattern and structure between scion and rootstock.
5. Inspection: Engineer may inspect plants either at place of growth or at Site, before planting, for compliance with requirements for genus, species, variety, size, and quality. Engineer retains right to inspect plants further for size and condition of ball and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of Work. Immediately remove rejected plants from Site.
    a. Notify Engineer of sources of planting materials, minimum of 14 days in advance of delivery to Site.
6. Do not prune plants before delivery, except as approved by Engineer, in writing. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape.
7. Requirements for Balled and Burlapped Plants:
    a. Where shown to be balled and burlapped, provide plants dug with a firm, natural ball of earth in which they are grown.
    b. Provide ball size of not less than the diameter and depth recommended by ANSI Z60.1 for the type and size of plants required. Increase ball size or modify ratio of depth to diameter as required to encompass the fibrous and feeding root system necessary for full recovery of plants subject to unusual or atypical conditions of growth, soil conditions or horticultural practice.
    c. Wrap and tie earth ball as recommended by ANSI Z60.1 for the size of balls required. Drum-lace balls with a diameter of 30-inches or greater.
8. Requirements for Container Grown Plants:
    a. Where shown as acceptable, provide healthy, vigorous, well-rooted plants established in the container in which they are sold. Provide balled and burlapped stock, when required plants exceed maximum size recommended by ANSI Z60.1 for container grown plants.
    b. Containers: Use rigid containers that will hold ball shape and protect root mass during shipping. Provide plants established in containers of not less than the minimum sizes recommended by ANSI Z60.1 for the kind, type and size of plant required.
9. Requirements for Bare-Root Plants:
    a. Where shown to be bare root, provide plants with a heavy fibrous root system developed by transplanting or root pruning and with not less than the minimum root spread recommended by ANSI Z60.1 for the kind and size of plant required.
    b. Provide freshly dug bare-root plants.
    c. Immediately after digging up bare-root plants, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

D. Pre-installation Conference:
1. Prior to commencement of planting and associated Work, Contractor shall schedule and meet at the Site with the landscape installer, the installers of other work in and around planting areas that follows the planting Work, including fencing Work specified in Section 32 31 00, Fences, and Engineer and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the planting Work, including the following:

a. Review Project requirements and the Contract Documents.
b. Review required submittals, both completed and yet to be completed.
c. Review availability of water and methods of delivery.
d. Review status of below-grade work and required access during planting and extended service periods.
e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
f. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
g. Review procedures needed for protection of plantings during the remainder of the construction period.
h. Review required inspection, testing, and certifying procedures.

2. Record the discussions of the conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Planting schedule showing scheduled start and finish dates for each type of planting in each area of Site.
2. Product Data:
a. Manufacturer's specifications and installation instructions for all materials required.
b. Composition and analysis of commercial fertilizers and all purchase receipts showing the total quantity actually purchased for this Project.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Certificates of inspection as may be required by governing authorities having jurisdiction at the Site to accompany shipments, and manufacturer's certified analysis for soil amendments and fertilizer materials.
b. For standard products, submit other data certifying that materials comply with specified requirements.
2. Test and Evaluation Reports:
a. An analysis made by an approved laboratory stating the mechanical and chemical analysis of the peat humus proposed for use.
b. Soil analysis reports for existing soil and imported manufactured topsoil, as specified. Include recommendations for remediating existing soil into acceptable topsoil as a component of planting soil mix.
3. Qualifications Data:
a. Landscape installer.
b. Landscape supervisor.
c. Testing agency.
4. Source Quality Control Submittals:
a. Written statement providing the location from which manufactured topsoil is to be obtained and the names and addresses of the suppliers.

C. Closeout Submittals: Submit the following:
   1. Care and Maintenance Data:
      a. Report with instructions recommending procedures to be established by Owner for full care, vigorous growth and maintenance of each type of plant specified, with specific recommendations for type of care, insect and disease prevention and special winter protection measures to be performed for each type of plant, for each month of the year. Include color pictures of each type of plant used in the Project, showing full plant form and close-ups of leaf and flower forms, along with botanical and common names adjacent to written full care and maintenance recommendations.
      b. Submit report prepared in Microsoft Word or Adobe portable document format, with scanned pictures as specified, and provide Owner with two copies on compact disc.
      c. Submit prior to expiration of specified extended service periods.
   2. Warranty Documentation:
      a. Submit written warranty, signed by Contractor and landscape installer, as specified.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver each type of plant as the Work progresses, after preparations for planting that specific type of plant is completed, and when plants will be planted immediately upon arrival at the Site. Do not stockpile plants on-Site.
   2. Deliver packaged materials in original, unopened containers, legibly showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery. Provide protective covering.
   3. Do not drop plants during delivery.
   4. Immediately remove unacceptable material from Site.

B. Storage of Materials:
   1. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage, and keep roots moist.
   2. Set balled stock on ground and cover ball with soil, moistened peat moss or other acceptable material.
   3. Heel-in bare root plants in a bed containing adequate peat moss to keep roots in a moist condition. Soak roots in water for two hours before planting.
   4. Store and cover materials to prevent deterioration. Remove packaged materials that have become wet, or show deterioration or water marks, from Site.

C. Handling of Materials:
   1. Handle balled and burlapped plants so that the ball will not be loosened or broken. Immediately remove split, broken or loosened balled and burlapped material from Site and replace with new material.
   2. Do not remove container-grown plants from containers until planting time.
   3. Do not lift or drag plants by stems or trunks. Handle plants by lifting root ball or container.
   4. Water as necessary to maintain plant root systems in a moist condition.

1.7 PROJECT CONDITIONS

A. Existing Conditions:
   1. Obstructions Below Ground and Utilities: Exercise extreme caution in all planting operations, as there are underground electric and telephone cables, sewer lines and water lines throughout the entire Site. Study and be familiar with the location of these obstructions

and underground utilities. Place plantings, where shown in the proximity of these obstructions and underground utilities, clear of any interference. Repair all damages to obstructions and underground utilities caused by the Work of this Section.

B. Environmental Requirements:
   1. Proceed with and complete the Work as rapidly as portions of the Site become available, working within the seasonal limitations for each kind of plant shown.
   2. Herbicides, chemicals and insecticides shall not be used on areas bordering wetlands.
   3. Do not resort to chemical control measures at the first sign of insect or disease attack. Make an attempt to determine the environmental cause of the attack and take corrective measures.
   4. Apply chemical insect and disease measures locally and specifically to the area and type of planting in need of such insect and disease control, so as not to damage plantings, or endanger the environment. Select natural chemical controls specific to the type of insect or disease encountered, or provide naturally controlling insect predators and bacterial controls for release at the Site.
   5. Plantings exhibiting a broad and heavy infestation of insects or diseases, or where insects or diseases have disfigured plantings such that they no longer provide their intended aesthetic effect, shall be replaced with new plantings.

C. Scheduling:
   1. Coordinate planting with specified extended service periods to provide required service from date of acceptable completion of each type of planting. Planting periods shall be per supplier recommendations.
   2. Do not begin planting until water, acceptable for use and adequate in supply, is available on-Site and can be successfully transported to the areas of Work. Coordinate provision of adequate and acceptable water supply with Project schedule.
   3. Do not proceed with installation of plants until all subgrade utility services have been installed, are operating successfully and have been approved by Engineer.
   4. Plant only after final grades are established and prior to planting of lawns and meadows, unless otherwise acceptable to Engineer. If planting occurs after lawn and meadow Work, protect lawn and meadow areas and promptly repair damage to lawns and meadows resulting from planting operations.
   5. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage to protect during digging, handling, and transportation.
      a. One week before evergreen trees and deciduous trees and shrubs in full leaf are to be dug, spray with anti-desiccant at nursery before moving and again two weeks after planting.
      b. Apply anti-desiccant to evergreens, again, immediately after the first frost.

1.8 ALTERNATIVES

A. Do not select plant material differing from that shown, without consulting Engineer for approval.

B. Plant material differing from that shown may be allowed by Engineer, at the varietal level only. Submit proof of non-availability and proposal for types of equivalent material.
   1. Where custom propagation is indicated, current non-availability shall not be cause for recommending alternatives to plants shown.

C. Bring to the attention of Engineer plant selections believed to be unsuitable for the microclimate or ecoregion of the Project, based on USDA information specified, or other authoritative sources.

1.9 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents.

B. Special Warranty: Warrant the following plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate care and maintenance, or abuse by Owner, or incidents that are beyond Contractor's control.
   1. Warranty Period for Trees and Shrubs: One year from date of end of extended service period.
   2. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   3. A limit of one replacement of each plant will be required, except where losses or replacement failures are due to Contractor's failure to comply with specified requirements.

1.10 EXTENDED SERVICE

A. Extended Landscape Service:
   1. Begin extended service immediately after each planted area is acceptably completed. Provide extended service for not less than the following periods:
      a. Trees and Shrubs: 90 days after trees and shrub plantings are acceptably completed.
   2. Prune, cultivate, water, weed, fertilize, shade, mist, restore planting saucers, tighten and repair stakes and guy supports, and reset plantings to proper grades or vertical position, as required to establish healthy, viable plantings.
      a. Do not allow plantings to wilt or show other signs of environmental stress. Visit the Site twice a week during the extended service periods, to inspect the condition of the plantings and immediately provide required care.
      b. Contractor shall provide landscape installer who shall be available on-call if notified between regular visits that plants require critical care or maintenance, throughout the time of extended service periods.
   3. Check and observe plantings for signs of insect and disease attack. Take corrective measures immediately upon notice of such attack. Control damaging insects and diseases, as specified.
   4. Restore or replace damaged tree wrappings.
   5. Remove dead plants immediately. Replace immediately, unless required to plant in the succeeding planting season.

B. Provide sufficient water to ensure that the top six inches of the planting bed mix remains moist at all times.
   1. Apply water using a 1-inch diameter hose with an attached metering gauge.
   2. For trees in seeded areas or mulched beds, apply water to the ground surface directly under the canopy. Apply water at a sufficiently slow rate to prevent water run-off from the soil surface but great enough to provide 0.2-inches of water per square foot of canopy area per hour for five hours each week.

C. Any decline in the condition of plants shall require Contractor to take immediate action to identify potential problems and undertake corrective measures. If required, engage professional arborists or horticulturists to inspect plants, identify problems and recommend correctives procedures. Advise Engineer of all such actions and submit inspection and recommendation reports.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General Landscape Design Criteria:
   1. Provide plant materials true to name and variety, established in Hortus III.
   2. Provide nursery-grown plants complying with ANSI Z60.1, typical of their species or variety and with a normal habit of growth for type of plant required, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous plants free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
   3. Label each tree and shrub and all bundles or flats of plants with securely attached, waterproof tag bearing legible designation of botanical and common name.

2.2 SHADE AND FLOWERING TREES

A. Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

2.4 TOPSOIL

A. Topsoil shall be in accordance with Section 32 9200, Turf and Grass

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, weed-free organic matter, produced by the aerobic decomposition of organic residues; pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch screen; soluble salt content of 5 to 10 decisiemens/meter; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Peat: Partially decomposed stems and leaves of several species of sphagnum moss; finely divided or granular texture. Supply shredded material, free from lumps, wood, roots, stones, decomposed collodial residue and other extraneous foreign matter, capable of passing through a 1/2-inch screen, which can easily be incorporated with the soil. Supply material that has been conditioned in storage piles after excavation for at least six months, including one freezing and thawing period. Supply peat humus with the following analysis:
   1. Not less than 90 percent organic matter by weight on an ovendry basis.
   2. pH range of 3.4 to 4.8.
   3. Moisture content 35 percent at time of incorporation into soil.
   4. Water absorbing ability 150 percent to 350 percent by weight.

C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with at least 0.15 pounds of ammonium nitrate or 0.25 pounds of ammonium sulfate per cubic foot of loose sawdust or ground bark.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of four percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral char-acter, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: When applied, composition of fertilizer shall provide one pound of nitrogen per 1000 square feet; including four percent phosphorous, and two percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following compo-sition:
   1. Composition: Twenty percent nitrogen, ten percent phosphorous, and ten percent potassium, by weight.

2.7 MULCHES

A. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch screen; soluble salt content of 5 to 10 decisiemens/meter; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Wood Chip Mulch: Provide either hardwood or softwood chips as produced by any standard chipping machine containing no wood shavings, sawdust or foreign material such as stones. Chip sizes larger than 3-inches in greatest dimension are not acceptable.

2.8 STAKES AND GUYS

A. Upright and Guy Stakes: Rough-sawn, sound, hardwood or softwood obtained from certified sustainable managed forests, free of knots, holes, cross grain, and other defects, 2-inches by 2-inches by length indicated, pointed at one end.

B. Guy and Tie Wire: ASTM A 641, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106-inch in diameter.

C. Guy Cable: Five-strand, 3/16-inch diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3-inches long, with two 3/8-inch galvanized eyebolts.

D. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2-inch in diameter, black, cut to lengths required to protect tree trunks from damage.

E. Flags: Standard surveyor's plastic flagging tape, white, 6-inches long.

2.9 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch wide minimum, with stretch factor of 33 percent.

C. Provide herbicides, chemicals and insecticides as needed for disease, fungus or pest control. All herbicides, chemicals and insecticides shall be bear approval labels indicating they are approved by the USDA for the intended uses and application rates.

2.10 PLANTING SOIL MIXES

A. Follow recommendations of soil-testing laboratory for modifying on-Site soil and manufactured soil, for use as topsoil.

B. Preparation of Planting Soil Mix:
   1. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
   2. Mix specified soil amendments and fertilizers with topsoil at the rates required to produce the pH needed for that particular planting and as specified. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.
   3. Provide planting soil mix proportions as follows:

Percent by Volume	Material
40 percent	Screened topsoil
25 percent	Peat Humus
25 percent	Compost
10 percent	Coarse Sand

   4. Add five pounds 5-10-5 commercial fertilizer and three pounds of bonemeal per cubic yard of planting soil mix.
   5. For pit and trench type backfill, mix planting soil prior to backfilling, and stockpile at the Site.

6. Mix lime with dry soil prior to mixing of fertilizer. Prevent lime from contacting roots of acid-loving plants.
7. Apply phosphoric acid fertilizer (other than that constituting a portion of complete fertilizers) directly to subgrade before applying planting soil mix and tilling.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the subgrade, verify the elevations, observe the conditions under which planting Work is to be performed, and notify Engineer, in writing, of unsatisfactory conditions. Do no proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Inspect plants for injury, insect infestation, and improper pruning.

C. Do not begin planting or wrapping of trees until deficiencies are corrected, or plants, replaced.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out plants at locations directed by Engineer. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING BED ESTABLISHMENT

A. Remove all existing soil from planting beds to the depth shown, but not less than 12-inches, so that finished plantings are level with adjacent final lines, grades and elevations after addition of planting soil mix and after light rolling and natural settlement.

B. Loosen subgrade of planting beds to a minimum depth of 6-inches. Remove stones larger than 2-inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off-Site.
   1. Apply superphosphate fertilizer directly to subgrade before loosening.

C. Spread planting soil mix to a depth required meeting finish grades after natural settlement. Do not spread if planting soil mix or subgrade is frozen, muddy, or excessively wet.
   1. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4-inches of subgrade. Spread remainder of planting soil mix.

D. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

E. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.4 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation. Dispose of subsoil removed from pits and trenches in a legal manner, off-Site.
   1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
   2. Excavate at least 12-inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.

B. Obstructions: Notify Engineer if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

C. Drainage: Notify Engineer if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

3.5 TREE AND SHRUB PLANTING

A. Set plants plumb and in center of pit or trench with top of root ball set such that it will be 1-inch above adjacent finish grades, at plant stem, after planting soil mix has settled.
   1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use plant if root ball is cracked or broken before or during planting operation.
   2. Place planting soil mix around root ball in layers. Each layer shall not be more than 6-inch deep. Tamp to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
   3. Remove all soil from around the root flare of the stem of each plant and from the top of the root ball to determine the true depth of the root flare. Plant with root flare at surface of finish planting soil mix.

B. Carefully remove root ball from container without damaging root ball or plant.
   1. After removal of plant from container, or sides from box, tease out feeder roots to assure positive contact and embedment into planting soil.

C. Set fabric bag-grown plants plumb and in center of pit or trench with top of root ball 1-inch above adjacent finish grades.
   1. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use plant if root ball is cracked or broken before or during planting operation.

D. Set and support bare-root plants in center of pit or trench with root collar or trunk flare 1-inch below adjacent finish grade. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots. Tamp final layer of backfill. Remove injured roots by cutting cleanly; do not break.

E. Organic Mulching: Apply 2-inch average thickness of organic mulch extending 12-inches beyond edge of planting pit or trench. Do not place mulch within 3-inches of trunks or stems.

F. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without

causing girdling. Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping.

G. Perform complete sequence of planting steps for each plant within the same day.

H. Dish top of backfill to allow for mulching. Provide dish four feet in diameter approximately 4-inches deep around each tree, with planting soil berm around edge of excavations to form shallow saucer to collect water.

I. After watering, any settlement within basins shall be refilled to required grade with planting soil mix.

3.6 TREE AND SHRUB PRUNING

A. Prune, thin out and shape trees in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by the Engineer, do not cut tree leaders. Remove only injured or dead branches from ornamental flowering trees, if any. Prune to retain natural character and accomplish their use in the landscape design. Required tree sizes are the size after pruning.
   1. Remove all dead wood and suckers, and all broken and badly bruised branches.

B. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

C. Paint cuts over 1/2-inch in size with standard tree wound compound, covering exposed, living tissue.

D. All pruning wounds shall show vigorous bark on all edges at the time of harvest.

3.7 GUYING AND STAKING

A. Guy and stake trees immediately after planting.

B. Upright Staking and Tying: Stake trees of 2-inches through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of two stakes of length required to penetrate at least 18-inches below bottom of backfilled excavation and to extend at least 72-inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses. Support trees with two strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree. Use the number of stakes as follows:
   1. Use two stakes for trees up to 12 feet high and 2-1/2-inches or less in caliper.
   2. Use three stakes for trees greater than 12 feet, but less than 14 feet high, and up to 4-inches in caliper. Space stakes equally around trees.

3.8 ACCEPTANCE CRITERIA FOR PLANTS

A. Planting Work will be considered acceptable when:
   1. Shade and Flowering Trees: When firmly planted, properly located and vertically upright with all securement devices and accessories, mulches, and saucers formed and in-place; with plant showing no signs of environmental stress, disease, insect infestations, mechanical damage or disfigurements such as suckers or watersprouts. Twigs and branches shall have a

full bud set for their full length including terminal buds. Buds shall be swelling or provide other indications of becoming vigorous, healthy growth.

2. Deciduous Shrubs: When firmly planted, properly located and vertically upright, with all mulches and saucers formed and in-place; with plant showing no signs of environmental stress, disease, insect infestations, damage or other disfigurement. Twigs and branches shall have a full bud set for their full length including terminal buds. Buds shall be swelling or provide other indications of becoming vigorous, healthy growth.

3.9 CLEANUP AND PROTECTION

A. Protect plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and extended service periods. Treat, repair, or replace damaged planting.

B. Protection includes all temporary fences, barriers and signs and other Work incidental to proper maintenance.

3.10 INSPECTION AND ACCEPTANCE

A. Where plants do not comply with specified acceptance criteria, replace plants and continue extended service period until plants comply with criteria for acceptance.

END OF SECTION 32 9300

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SECTION 33 0505

BURIED PIPING INSTALLATION

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections or other contracts.
b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
c. Work on or affecting existing buried piping.
d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
e. Supports, restraints, and thrust blocks.
f. Field quality control, including testing.
g. Cleaning and disinfecting.
h. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Process Integration.

C. Related Sections:
1. Section 31 2305 Excavation and Fill.
2. Section 03 3000, Cast-In-Place Concrete.
3. Section 09 9100, Painting.
4. Section 40 0513, Process Piping

1.2 REFERENCES:

A. Standards referenced in this Section are:
1. ASME Boiler and Pressure Vessel Code.
2. ASME B31.3, Process Piping.
3. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
4. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
5. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
6. ASTM F1417, Test Method for Installation Acceptance of Plastic Gravity Sewer Lines using Low-Pressure Air.

7. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.
8. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
9. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
10. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
11. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
12. ANSI/AWWA C651, Disinfecting Water Mains.
13. AWWA M23, PVC Pipe - Design and Installation.
14. AWWA M41, Ductile-Iron Pipe and Fittings.
15. AWWA M55, PE Pipe - Design and Installation.
16. ASCE 37, Design and Construction of Sanitary and Storm Sewers.
17. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 QUALITY ASSURANCE:

A. Regulatory Requirements:
1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including.
a. Warren County.
2. Obtain required permits for Work in roads, rights of way, railroads, and other areas of the Work.

1.4 SUBMITTALS:

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
2. Product Data:
a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
3. Testing Procedures:
a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain Engineer's approval prior to commencing testing.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
2. Field Quality Control Submittals:
a. Results of each specified field quality control test.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.

b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Delivery:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

B. Storage:
1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
2. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.

C. Handling:
1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 – PRODUCTS

2.1 MATERIALS:

A. Piping materials are specified in the Buried Piping Schedule on the project drawings. Piping materials shall conform to Section 40 0513 Process Piping.

B. General:
1. Pipe Markings:
a. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Polyethylene Encasement:
1. Polyethylene may be supplied in tubes or sheets.
2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

2.2 BURIED PIPING IDENTIFICATION:

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule on the Drawings] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 9100, Painting.
3. Manufacturer: Provide products of one of the following:
    a. Brady Corporation
    b. Seton Identification Products
    c. Marking Services, Inc.
    d. Or equal.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule on the Drawings] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 9100, Painting.
3. Manufacturer: Provide products of one of the following:
    a. Brady Corporation
    b. Seton Identification Products
    c. Marking Services, Inc.
    d. Or equal.

PART 3 – EXECUTION

3.1 INSTALLATION:

A. General:
1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from Engineer before proceeding.
3. Engineer will observe excavations and bedding prior to laying pipe by Contractor. Notify Engineer in advance of excavating, bedding, pipe laying, and backfilling operations.
4. Minimum cover over buried piping shall be 4.5 feet, unless otherwise shown or approved by Engineer.
5. Earthwork is specified in Section 31 2305, Excavation and Fill.
6. Excavation in excess of that required or shown, and that is not authorized by Engineer shall be filled at Contractor's expense with granular material furnished, placed, and compacted.
7. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.

B. Separation of Sewers and Potable Water Piping:
1. Horizontal Separation:

a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 24 inches above top of sewer.
c. Exception:
1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2. Vertical Separation:
a. Provide minimum vertical distance of 24 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.
c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
d. Exceptions:
1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

C. Plugs:
1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to Engineer.

D. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.
1. Trench excavation and backfill, and bedding materials shall conform to Section 31 2305, Excavation and Fill , as applicable.
2. Where Engineer deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with 31 2305, Excavation and Fill.
3. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.

4. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
5. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
6. Do not lay pipe until Engineer approves bedding condition.
7. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

E. Laying Pipe:
1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
   a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
   b. Concrete Pipe: AWWA M9.
   c. Thermoplastic Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA M45, AWWA, M55.
   d. Sanitary and Storm Sewers: ASCE 37.
2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by Engineer. Remove and reinstall pipes that are not installed correctly.
3. Slope piping uniformly between elevations shown.
4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by Engineer.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by Engineer.
7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in vertical position.
8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by Engineer.
10. For PVC and CPVC piping with solvent welded joints, 2.5-inch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
13. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by Engineer for special conditions.
15. Touch up protective coatings in manner satisfactory to Engineer prior to backfilling.
16. Notify Engineer in advance of backfilling operations.
17. On steep slopes, take measures acceptable to Engineer to prevent movement of pipe during installation.

18. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
19. Exercise care to avoid flotation when installing pipe in cast in-place concrete, and in locations with high groundwater.

F. Polyethylene Encasement:
1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.
2. Polyethylene encasement installation shall be in accordance with ANSI/AWWA C105.

G. Geotextile Wrap:
1. Provide polyethylene wrap to prevent migration of fines into the drainage pipe.
2. Contractor shall take any necessary precautions to prevent damage to the geotextile wrap.

H. Jointing Pipe:
1. Ductile Iron Mechanical Joint Pipe:
   a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
   b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
   c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
   d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
   e. Push gland toward socket and center gland around pipe with gland lip against gasket.
   f. Insert bolts and hand-tighten nuts.
   g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	**Bolt Diameter (inches)**	**Range of Torque (ft-lbs)**
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

   h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.
   i. restrained mechanical joints shall be in accordance with Section 40 0513 Process Piping.
2. Ductile Iron Push-On Joint Pipe:
   a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.
   b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.

c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.
e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.
f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.

3. Prestressed Concrete Cylinder Pipe Joints:
a. Immediately before making the joint, completely clean bell and spigot surfaces to be jointed.
b. Apply lubricant supplied by pipe manufacturer to sealing surfaces of bell, spigot, and gasket. After lubrication, install gasket in spigot groove and ensure that stretch in the gasket is equalized.
c. After pipe is lowered into place, align spigot and bell so that spigot will squarely enter the bell.
d. Before joint is fully assembled, check position of gasket in bell using methods recommended by pipe manufacturer and accepted by Engineer.
e. If gasket is in correct position around entire circumference of the bell, remove temporary joint stoppers, if used, and insert pipe completely into bell. If gasket is not in proper location, open the joint and reinstall using a new gasket.
f. Where joint opening is required to make grade or alignment adjustment, joint shall first be installed completely closed, then opened as necessary on one side. Joint openings shall not be greater than 75 percent of maximum opening recommended by pipe manufacturer.
g. Strap diaper to outside of completed joint, straddling the external joint recess. Pour grout mix consisting of portland cement and sand in proportions recommended by pipe manufacturer to completely fill external joint recess. In lieu of joint diaper, Contractor may, with written approval of pipe manufacturer, use polyurethane foam joint protector with unhydrated portland cement dispersed throughout protector. Protector shall have the cross-sectional shape required for the type of joint being installed and shall be formed in loop to fit size of pipe on which it is to be used.
h. Coat exterior exposed steel portions of pipe, flanges, couplings, bolts and nuts with two coats each eight-mils minimum dry film thickness, of high-build epoxy or bituminous coating manufactured by Tnemec, or equal.
i. Maintain sufficient quantity of joint lubricant, gaskets, joint diapers, and joint fillers at the Site at all times.
j. Do not use gaskets that have been scored or otherwise damaged.
k. Where welded joints are required to handle thrust, steel spigot shall be cut at trailing edge of gasket groove to provide surface suitable for field-welding. Field-welded joints shall be full circumferential welds designed to take thrust at joint location. Provide minimum 3/16-inch weld. Exposed steel surface of pipe joints shall have

temporary protection system of rust and corrosion inhibitor applied that need not be removed prior to welding. After welding is complete, joint protection shall be completed with interior and exterior cement mortar grouting.

4. Thermoplastic Pipe Joints:
   a. Solvent Cement Welded Joints:
      1) Bevel pipe ends and remove all burrs before making joints. Clean pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
      2) Use solvent cement supplied or recommended by pipe manufacturer.
      3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
      4) Take appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.
   b. Bell and Spigot Joints:
      1) Bevel pipe ends, remove all burrs, and provide a reference mark at correct distance from pipe end before making joints.
      2) Clean spigot end and bell thoroughly before making the joint. Insert O-ring gasket while ensuring that gasket is properly oriented. Lubricate spigot with manufacturer's recommended lubricant. Do not lubricate bell and O-ring. Insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.
5. Mechanical Coupling Joints:
   a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings specified in Section 40 0513, Process Piping.
   b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.
   c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
   d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove clamps from coupling. Slide coupling over plain ends of pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with torque wrench to torque recommended by manufacturer.
6. HDPE Pipe Joints:
   a. Butt Fusion Welded Joints:
      1) Install joints in accordance with manufacturer's instructions using hydraulic butt fusion machine or manual machine equipped with torque wrench. Equipment shall be able to achieve and maintain heating tool temperature range of 400 to 450 degrees F and an interface pressure of 60 to 90 psi.

2) Clean interior and exterior of pipe and fitting ends with clean, dry, lint-free cloth.
3) Align ends to be joined in the fusion machine without forcing ends into alignment. Adjust alignment as necessary and tighten clamps to prevent slippage.
4) Place facing tool between ends to be joined and face them to provide clean, smooth, parallel mating surface. If stops are present, face ends down to the stops. Remove all shavings after facing without touching ends.
5) Re-check alignment of ends and check for slippage against fusion pressure. There shall be no detectable gaps between ends. Align outside diameters.
6) Heating tool shall maintain pipe manufacture's recommended temperature range. Place the tool between ends to be joined. Move ends against heating tool to achieve full contact. Hold ends against heating tool without force until the following melt bead size is formed:

Pipe Diameter (inches)	Required Melt Bead Size (inches)
2 to 4	1/8 to 3/16
4 to 12	3/16 to 1/4
12 to 24	1/4 to 7/16
24 to 54	7/16 to 9/16

7) Upon forming proper melt bead size, quickly separate ends and remove heating tool. Quickly inspect melted ends and bring ends together applying joining force recommended by manufacturer, using 60 to 90 psi interfacial pressure to form double bead rolled over surface of pipe on both ends.
8) Hold joining force against ends until joint is cool to the touch. Cooling period shall be 30 to 90 seconds per inch of pipe diameter. Heavier wall thicknesses may require longer cooling times as recommended by pipe manufacturer.
9) Upon completing joint, inspect to verify double bead has been formed on both sides, uniformly rounded and consistent in size all around joint. Remove faulty joints and re-joint.

7. HDPE Double Containment Pipe (Containment and Carrier Pipe):
   a. Install joints of double containment piping system in accordance with pipe manufacturer's instructions. Joints shall be butt fusion welded.

I. Backfilling:
1. Conform to applicable requirements of Section 31 2305, Excavation and Fill.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

J. Connections to Valves and Hydrants:
1. Install valves and hydrants as shown and indicated in the Contract Documents.
2. Provide suitable adapters when valves or hydrants and piping have different joint types. Provide thrust restraint at all hydrants and at valves located at pipeline terminations.

K. Transitions from One Type of Pipe to Another:
1. Provide necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

L. Closures:
1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION:

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
   1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
   2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
   3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
   4. Tape shall be spread flat with message side up before backfilling.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
   1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
   2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
   3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
   4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT:

A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.

B. Thrust restraint may be accomplished by using restrained pipe joints, or concrete thrust blocks. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule on the drawings.

C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.

D. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
      a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 0513 Process Piping ; lugs and tie rods; or other joint restraint systems approved by Engineer.
      b. Steel Pipe Joints: Provide butt welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Buried Piping Schedule on the Drawings. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
      c. Thermoplastic and HDPE Joints: Where bell and spigot type or other non restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of Engineer.
      d. Prestressed Concrete Cylinder Pipe Joints: Restrain utilizing clamp type restrained joint, snap ring-type restrained joint, or by welding. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle thrust forces at maximum design stress of 12,500 psi. Thrust forces in longitudinales must be transmitted directly to steel joint bands using welded connections sufficient to carry stresses involved. No allowance for the concrete to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M9.

e. Joints for Concrete Pipe Other than Prestressed Concrete Cylinder Pipe: Restrain joints utilizing clamp type restrained joint or snap ring-type restrained joint.

E. Concrete Thrust Blocks:
1. Provide concrete thrust blocks on pressure piping at changes in alignment of 15 degrees or more, at tees, plugs and caps, and where shown or indicated in the Contract Documents. Construct thrust blocks of Class B concrete, conforming to Section 03 3000, Cast-In-Place Concrete.
2. Install thrust blocks against undisturbed soil. Place concrete so that pipe and fitting joints are accessible for repair.
3. Concrete thrust block size shall be as shown on the drawings or as approved by Engineer.

3.4 WORK AFFECTING EXISTING PIPING:

A. Location of Existing Underground Facilities:
1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.

B. Taking Existing Pipelines and Underground Facilities Out of Service:
1. Conform to Section 01 3113, Coordination.
2. Do not take pipelines or Underground Facilities out of service unless specifically listed in Section 01 3113, Coordination, or approved by Engineer.
3. Notify Engineer in writing prior to taking pipeline or Underground Facilities out of service. Shutdown notification shall be provided in advance of the shutdown in accordance with the General Conditions and Section 01 3113, Coordination.

C. Work on Existing Pipelines or Underground Facilities:
1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
4. Conform to applicable requirements of Section 01 3113, Coordination, and Section 01 7324, Connections to Existing Facilities.

3.5 FIELD QUALITY CONTROL:

A. General:
1. Test all piping, except as exempted in the Buried Piping Schedule on the Drawings.
2. When authorities having jurisdiction are to witness tests, notify Engineer and authorities having jurisdiction in writing at least 48 hours in advance of testing.
3. Conduct all tests in presence of Engineer.
4. Remove or protect pipeline-mounted devices that could be damaged by testing.
5. Provide all apparatus and services required for testing, including:
a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain Owner's operations.
b. Temporary bulkheads, bracing, blocking, and thrust restraints.

6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
7. Unless otherwise specified, Owner will provide fluid required for hydrostatic testing. Contractor shall provide means to convey fluid for hydrostatic testing into piping being tested. Contractor shall provide fluid for other types of testing required.
8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by Contractor and that fails the test shall be repaired upon authorization of Owner. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:
1. Refer to the Buried Piping Schedule on the Drawings for type of test required and required test pressure.
2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Buried Piping Schedule on the Drawings:
   a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires separate test.
   b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
   c. Disinfect for bacteriological testing piping that conveys potable water.
4. Test Pressure:
   a. Use test pressures listed in Buried Piping Schedule on the Drawings.
   b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by Engineer based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
1. Conform to Section 40 0513 Process Piping.

D. Sewer Testing with Low Pressure Air:
1. Plug and bulkhead ends and lateral connections of pipe segment to be tested.
2. Required test pressure shall be increased by an amount equal to the elevation of groundwater above invert of lowest point of pipe segment being tested.
3. Test in accordance with requirements of authority having jurisdiction.
4. If there are no Laws and Regulations covering the test, use test procedures described in the following standards:
   a. Thermoplastic and HDPE Pipe: ASTM F1417.
   b. Concrete Pipe: ASTM C924.
   c. Clay Pipe: ASTM C828.

E. Vacuum Testing:
1. Plug and bulkhead ends and lateral connections of pipe segment or manhole to be tested.
2. Following set-up of test apparatus, draw vacuum of ten inches of mercury on pipe segment or manhole being tested.
3. Start test upon reaching specified test vacuum. Test duration shall be 15 minutes.

4. Record vacuum drop at end of test. If vacuum drop is greater than one inch of mercury, pipe segment or manhole fails the test and shall be repaired and retested. If vacuum drop is less than one inch of mercury, pipe segment or manhole passes the test.

F. Vertical Deflection Test for Thermoplastic, FRP, and HDPE Pipe:
1. Conduct vertical deflection test at least thirty days after backfill has been placed.
2. Use rigid ball or mandrel for deflection test, which shall have diameter of at least 95 percent of base inside diameter or average inside diameter of piping, depending on which is specified in applicable ASTM standard, including appendix, to which pipe is manufactured. Perform test without mechanical pulling devices. Re-install and retest pipe segments that exceed deflection of five percent.

G. Televised Inspection:
1. Televise completed sewer and appurtenant structures, including manholes and chambers, and provide to Engineer copy of video on digital video disc (DVD).
2. A second televised inspection is required one year after installation.
3. Repair apparent leaks in pipe Work in manner satisfactory to Engineer without additional cost to Owner and re-televise the pipe.
4. Inspection shall be performed by Subcontractor certified in Pipeline Assessment Certification Program (PACP) by National Association of Sewer Service Companies (NASSCO). Provide copy of PACP certification prior to starting inspection. Televising shall conform to coding and reporting standards and guidelines specified in PACP. Use same standards for lateral inspections, regardless of whether conducted using cleanout-launched or mainline-launched lateral camera. Identify report annotations, pipe conditions, and pipe defects in accordance with PACP. Severity ratings shall be calculated in accordance with PACP.
5. Camera for main line shall be pan-and-tilt, radial viewing, pipe inspection camera that pans plus-or-minus 275 degrees and rotates 360 degrees. Use camera with an accurate footage counter that displays on television monitor exact distance of camera from centerline of starting manhole. Use camera with height adjustment so that lens is always centered at one-half inside diameter or higher, in pipe being televised. Provide lighting system that allows features and condition of pipe to be clearly seen. Camera shall operate in 100 percent humidity. Camera, television monitor, and other components of video system produce a minimum 450-line resolution colored video picture. Picture quality and definition shall be satisfactory to Engineer. Camera for lateral televising shall be fixed and capable of moving from main line 80 feet up lateral, and conform in other respects to requirements for main line camera.

H. Bacteriological Testing:
1. Bacteriological testing for potable water lines, finished water lines, and other piping in accordance with the Buried Piping Schedule shall conform to Section 40 0513 Process Piping.

3.6 CLEANING AND DISINFECTION:

A. Cleaning, disinfection and bacteriological testing shall conform to Section 40 0513 Process Piping.

END OF SECTION 33 0505

SECTION 33 0513

MANHOLES AND STRUCTURES

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all precast, cast-in-place and masonry manholes and structures.

B. General:
1. Manholes and structures shall conform in shape, size, dimensions, material, and other respects to the details shown or as directed by Engineer.
2. Cast-iron frames, grates and covers shall be the standard frame and grate or cover unless otherwise shown and shall be as specified in Section 05 5600, Metal Castings.
3. Concrete for cast-in-place manholes and structures and for inverts in precast and masonry manholes and structures shall be Class "A" and shall conform to the requirements specified under Section 03 3000, Cast-In-Place Concrete.

C. Related Sections:
1. Section 03 3000, Cast-In-Place Concrete.
2. Section 05 5013, Miscellaneous Metal Fabrications.
3. Section 05 5600, Metal Castings.

1.2 REFERENCES:

A. Standards referenced in this Section are listed below:
1. American Society for Testing and Materials, (ASTM).
a. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.
b. ASTM C 923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
2. American Water Works Association, (AWWA).
a. AWWA C302, Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

1.3 SUBMITTALS:

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Submit drawings showing design and construction details of all precast concrete and cast-in-place manholes and structures, including details of joints between the manhole bases and riser sections and stubs or openings for the connections.

PART 2 – PRODUCTS

2.1 PRECAST CONCRETE MANHOLES AND STRUCTURES:

A. Precast manholes and structures shall conform to the details shown. Provide cast-in-place concrete bases where shown.

B. Except where otherwise specified precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accor¬dance with ASTM C 478, except as modified herein.

C. Precast, reinforced concrete manhole bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing or other imperfections.

D. Joints between manhole components shall be the tongue and groove type employing a single, continuous rubber O-ring gasket and shall conform to AWWA C 302. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel. Joints between the base sections, riser sections and top slabs of manholes 72-inches in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than 72-inches in diameter shall be provided with steel bell and spigot rings.

E. All precast manhole components shall be of approved design and of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall not be less than 5-inches. Concrete top slabs shall not be less than 8-inches thick.

F. Lifting holes, if used in manhole components, shall be tapered, and no more than two shall be cast in each section. Tapered, solid rubber plugs shall be furnished to seal the lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.

G. The point of intersection (P.I.) of the sewer pipe centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in the floor of each manhole base and protruding approximately 1-inch above the finished floor of the base.

H. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

I. The barrel of the manhole shall be constructed of various lengths of riser pipe manufactured in increments of one foot to provide the correct height with the fewest joints. Openings in the barrel of the manholes for sewers or drop connections will not be permitted closer than one foot from the nearest joint. Special manhole base or riser sections shall be furnished as necessary to meet this requirement.

J. A precast or cast-in-place slab or precast eccentric cone, as shown or approved, shall be provided at the top of the manhole barrel to receive the cast iron frame and cover.

2.2 RESILIENT CONNECTOR:

A. Sewer pipe to manhole connections on all sanitary sewers shall be flexible and watertight. Sewer pipe shall be sealed in the manhole section pipe openings with a resilient connector meeting the requirements of ASTM C 923. The resilient connector shall be manufactured by:
   1. Trelleborg Pipe Seals
   2. Press-Seal Corporation
   3. A-Lok Producs Inc.
   4. Or equal

2.3 MISCELLANEOUS METALS

A. Metal frames and covers and similar required items shall be provided as shown and in accordance with Division 05, Metals.

2.4 DROP CONNECTIONS:

A. Drop connections for manholes and structures shall be constructed where shown or directed by the Engineer and shall conform to the design and details shown. Pipe and fittings shall be ductile iron, reinforced concrete, or vitrified clay as shown or otherwise approved. Concrete for pipe encasement shall be Class "B" as specified under Section 03 3000, Cast-In-Place Concrete. Concrete shall be bonded to manhole in the manner shown or otherwise approved by Engineer.

PART 3 – EXECUTION

3.1 LAYING MASONRY:

A. Brick shall be satisfactorily wet when being laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The joints shall not be wider than 3/8-inch, except when the bricks are laid radially, in which case the narrowest part of the joint shall not exceed 1/4-inch. Masonry work shall be kept moist for a period of three days after completion, and precautions shall be taken to prevent freezing during cold weather.

B. For concrete block, the vertical keyways shall be completely filled with mortar.

C. Each grading ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

3.2 PLASTERING:

A. The outside of brick manholes and structures, brick stacks and grading rings shall be neatly plastered with 1/2-inch of cement mortar as the Work progresses.

3.3 MANHOLE BASES:

A. Precast bases shall be set on a crushed stone or crushed gravel foundation as shown. Precast bases shall be set at the proper grade and carefully leveled and aligned.

3.4 PRECAST MANHOLE SECTIONS:

A. Set sections vertical with steps and sections in true align¬ment. The base of the bell or groove end at joints between components shall be buttered with 1:2 cement-sand mortar to provide a uniform bearing between components. All joints shall be sealed with cement mortar inside and

out and troweled smooth to the contour of the wall surface. Raised or rough joint finishes will not be accepted.

B. Install sections, joints and gaskets in accordance with manufactur¬ers recommendations.

C. Lifting holes shall be sealed tight with a solid rubber plug driven into the hole from the outside of the barrel and the remaining void filled with 1 to 2 cement-sand mortar.

3.5 MANHOLE CHANNELS:

A. All invert channels through manholes and structures shall be constructed of Class "A" concrete. Channels shall be properly formed to the sizes, cross sections, grades and shapes shown or as ordered. Benches shall be built up to the heights shown or as directed by the Engineer and given a uniform wood float finish. Care shall be taken to slope all benches for proper drainage to the invert channel.

3.6 GRADING RINGS:

A. Grading rings or brick stacks shall be used for all precast and masonry manholes and structures, where required. Stacks or grade rings shall be a maximum of 12-inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the stack or grade rings shall be such as required to bring the manhole frame to the proper grade.

B. Each grade ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

C. Brick work shall be as specified in Article 2.2 and Article 3.1, above.

3.7 GRADING AT MANHOLES AND STRUCTURES:

A. All manholes and structures in unpaved areas shall be built so that the top of the casting is a minimum of 12-inches above finished grade or as otherwise shown or directed by the ENGINEER.. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level of the upper rim of the manhole frame, and the surface evenly graded on a 1 to 5 slope to the existing surrounding ground, unless otherwise shown or directed by the Engineer. The slope shall be covered with 4-inches of topsoil, seeded and maintained until a satisfactory growth of grass is obtained.

B. Manholes and structures in paved areas shall be constructed to meet the final surface grade. In paved areas on State Highways, all manholes and structures shall be 1/2-inch below final wearing surfaces. Manholes and structures shall not project above finished roadway pavements to prevent damage from snowplows.

C. Contractor shall be solely responsible for the proper height of all manholes and structures necessary to reach the final grade at all locations. Contractor is cautioned that Engineer'S review of Shop Drawings for manhole components will be general in nature and Contractor shall provide an adequate supply of random length precast manhole riser sections to adjust any manhole to meet field conditions for final grading.

3.8 MANHOLE WATERTIGHTNESS:

A. All manholes and structures shall be free of visible leakage. Each manhole shall be tested for leaks and inspected, and all leaks shall be repaired in a manner subject to Engineer'S approval. Manhole testing shall conform to the requirements of Section 33 0505, Buried Piping Installation.

3.9 FLEXIBLE PIPE JOINT AT MANHOLE BASE:

A. An approved flexible joint shall be provided between each pipe entering and exiting the manhole. This may be accomplished by the installation in the manhole base of the bell end of a pipe or by other means subject to approval of Engineer. Joints shall be similar to the approved pipe joints. The joint into the manhole base shall be completely watertight.

END OF SECTION 33 0513

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SECTION 33 4413

DRAINAGE STRUCTURES

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Scope:
1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all precast and masonry drainage structures, including drain inlets, catch basins, headwalls and similar structures.

B. General:
1. Structures shall conform in shape, size, dimensions, materials, and other respects to the details shown or as directed by the Engineer.
2. Cast iron frames, grates and covers shall be the standard frame and grate or cover, unless otherwise shown.
3. All concrete shall be Class "A" and shall conform to the require¬ments specified under Section 03 3000, Cast-In-Place Concrete.
4. Inverts shall be as shown and shall conform accurately to the size and elevation of the adjoining pipes.

C. Related Sections:
1. Division 31, Applicable Sections on Earthwork.
2. Section 03 3000, Cast-In-Place Concrete.
3. Section 05 5013, Miscellaneous Metal Fabrications.
4. Section 05 5600, Metal Castings.

1.2 QUALITY ASSURANCE:

A. Standards referenced in this Section are listed below:
1. American Society for Testing and Materials, (ASTM).
a. ASTM C 32, Specification for Sewer and Manhole Brick (Made from Clay or Shale).
b. ASTM C 139, Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
c. ASTM C 140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
d. ASTM C 207, Specification for Hydrated Lime For Masonry Purposes.
e. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.

1.3 SUBMITTALS:

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Submit drawings showing design and construction of all precast concrete.
2. Samples:
a. Submit for approval samples of brick, block, gaskets and accessories, if any, for the structures.

PART 2 – PRODUCTS

2.1 PRECAST PRODUCTS:

A. Where shown or otherwise approved by Engineer, precast concrete shall be used for items such as area drains, catch basins, splash pads, etc. Layout and details shall be as shown and specified. Design shall be adequate to withstand all loads imposed, including earth pressure, vehicle loads and construction loading.

B. Precast concrete sections shall conform to ASTM C 478, where applicable.

C. Where precast structures are made up of various precast components such as base sections, riser sections and top sections, the joint between sections shall be the tongue and groove type.

2.2 MISCELLANEOUS METALS:

A. Metal frames, covers, grates, troughs and similar required items shall be provided as shown and in accordance with Section 05 5600, Metal Castings or Section 05 5013, Miscellaneous Metal Fabrications.

PART 3 – EXECUTION

3.1 GRADING RINGS:

A. Grading rings or brick stacks shall be used for all precast and masonry structures, where required. They shall be constructed on the top slab on which the frame will be placed. The height of the stack shall be such as is necessary to bring the frame to the proper grade, but in no case greater than 12-inches.

3.2 PRECAST ITEMS:

A. Precast products shall be placed on a concrete or crushed stone bed, set at the proper grade and carefully leveled and aligned.

B. Backfill shall be carried up evenly on all sides of the structures to prevent overturning forces.

3.3 PIPE JOINT IN STRUCTURE BASE:

A. An approved joint shall be provided between each pipe entering and exiting the structure. Joint may be accomplished by the installation in the structure base of the bell end of a short pipe or by other means subject to approval of Engineer.

B. Pipes shall not protrude inside the structure, but shall be cut in an approved manner to be flush with the inside wall of the structure.

END OF SECTION 33 4413

SECTION 40 0513

PROCESS PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the Work of this Section, including but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Exposed, buried, interior and exterior process piping.

B. Piping associated with the following processes:
   1. All Water Treatment Process Piping
   2. All Process Waste Piping
   3. Compressed and Low Pressure Air Piping
   4. Membrane Cleaning System (MCS) Piping
   5. All chemical feed piping
   6. Sample water piping

C. Process piping excludes the following:
   1. Piping associated with HVAC systems.
   2. Piping associated with plumbing and sanitary waste systems.
   3. Storm drainage piping.
   4. Gutters and downspouts.
   5. Water distribution system.

1.3 QUALITY ASSURANCE

A. General: All materials shall be free from defects impairing strength and durability and be of the best quality for the purposes specified or shown on the Drawings. It shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected and be true to detail.

B. Manufacturer's Qualifications
   1. Provide piping and appurtenances that are the standard product in regular production by Manufacturers whose products have proven reliable in similar service for at least two years.
   2. Provide piping and appurtenances of the same type from a single manufacturer.
   3. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.
   4. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components

C. The Contractor shall be responsible for making all field measurements prior to installation of his work. Any deviations in measurements between the field conditions and the Drawings shall be immediately reported to the Engineer.

D. Testing
   1. Manufacturer's certified test results as defined for the type of pipe shall be stamped approved by the Contractor and forwarded to the Engineer as a Reference Submittal. No pipe shall be installed which does not meet the requirements of these Specifications.
   2. All pipe, joints, and fittings shall be pressure tested as required by this Specification for the type of pipe. The Contractor shall notify the Engineer or Owner, in writing, at least 48 hours prior to performing the tests.

E. All materials furnished under this Section shall have NSF 61 approval.

1.4 SUBMITTALS

A. Provide technical submittals in accordance with Division 01 Section “Submittal Procedures”, demonstrating piping and accessories conform completely to the requirements of this Section.

B. Product Data
   1. Catalog cut sheets and description of all items.
   2. Construction materials.
   3. Standard diameters, wall thicknesses and other pertinent dimensions of all sizes of piping and accessories.
   4. Support and anchor details with manufacturer's maximum recommended loads.
   5. Design calculations indicating support spacing requirements for all size pipe.

C. Shop Drawings
   1. Complete piping layout indicating type of pipe, diameter and location. Show dimensions from adjacent structure, equipment and other piping.
   2. Location of all pipe joints, sleeves, valves, and couplings.
   3. Location of all pipe supports and anchors.
   4. Details of pipe anchors, supports, couplings, and joints.
   5. Grooved joint couplings and fittings may be shown on drawings and product submittals, and shall be specifically identified by the manufacturer’s style or series designation.

D. Testing: Copies of all field test reports.

E. Contractor shall verify chemical compatibility of piping, solvents, gaskets, seals, o-rings, etc. for each chemical feed system. Provide chemical compatibility charts and manufacturer’s written verification of compatibility for each chemical feed system.

1.5 HANDLING, DELIVERY, AND STORAGE

A. General
   1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
   2. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.
   3. Interiors of piping shall be completely free of dirt and foreign matter.

PART 2 - PRODUCTS

2.1 AMERICAN IRON AND STEEL REQUIREMENTS

A. This project is being funded in part with loan and loan forgiveness funds from the Ohio EPA WSRLA Program and is subject to American Iron and Steel (AIS) requirements. See Division 00, Section "OEPA WSRLA Program Requirements."

2.2 PIPING

A. General
1. The outside of all piping, valves, and fittings shall bear the Manufacturer's standard marking for type, pressure, etc.
2. All pipe and fittings shall be equal to or better than the grade specified.
3. Whenever Specifications call for close bending or coiling, use Grade B pipe.
4. All piping material shall be new and free from defects and shall be subject to standard mill test before being shipped. No salvaged or used pipe shall be used.
5. Pipe shall be labeled.
6. Fittings shall have the Manufacturer's name or trademark legibly raised or cut into each piece, and shall bear the Manufacturer's standard marking for type, pressure, etc.
7. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
8. Victaulic grooved fittings and couplings and valves may be utilized in lieu of welded, threaded, or flanged joints as shown on the Drawings. Gasket selection and intended use shall be verified as suitable for the intended service as published in the manufacturer's latest literature. Installation shall be in accordance with the coupling manufacturer's latest published instructions.

B. Hardware
1. Unless indicated otherwise, provide hardware of the following materials for all piping/valve hardware (bolts, nuts, and washers).
   a. Exposed (painted): Zinc Plated.
   b. Exposed (unpainted): 304 SST.
   c. Buried: 316 SST or Cor-Blu.
   d. Submerged: 316 SST.
2. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the bolts.
3. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.

C. Ductile Iron Pipe (DIP or DI)
1. Pipe
   a. Standards
      1) Flanged: ANSI/AWWA C115/A21.15.
      2) Nonflanged: ANSI/AWWA C151/A21.51.
      3) Thickness Class: 53 (Unless noted otherwise on Drawings).
   b. Lining
      1) Cement-mortar lining (All piping, unless indicated otherwise in the piping schedule)
         a) ANSI/AWWA C104/A21.4.
      2) Glass Lining (where indicated in the piping schedule)
         a) Glass Lining: Vitreous material that is smooth, continuous and formulated to prevent the adherence of grease, scum and crystalline

metal salt deposits in sludge, scum and related process piping systems in wastewater and sewage treatment systems.

b) Provide lining consisting of two coats, separately applied and separately fired at a maturing temperature of approximately 1400 degrees F (760 degrees C) creating a molecular bond with the base metal and a total minimum lining thickness of 8-10 mils.

c) Lining minimum hardness: 5-6 on the MOHS scale.

d) Provide lining capable of withstanding an instantaneous thermal shock of 350 degrees F (195 degrees C) differential without crazing, blistering or spalling.

e) Provide lining capable of withstanding a strain of 0.001 inch/inch (0.025 mm/mm), the yield point of the base metal, without damage to the glass lining.

f) Provide lining resistant to corrosion of between pH of 3 to 10.

g) Fabricators: Custom-Fab or Engineer Approved Equal.

c. Grooved end pipe shall be Class 53 (min), with ends that comply with ANSI / AWWA C606.

d. Coating

1) Buried pipe: 1 mil asphalt coating, AWWA C151.

2) Exposed pipe to be painted: Factory prime coat compatible with finished coat system.

2. Joints

a. Types: As shown on the Drawings—grooved joints are acceptable at locations where flanged joints are shown on the drawings. If not designated, use grooved or flanged joints for exposed piping and mechanical joints for buried pipe. Use grooved joints upstream and downstream of flow meters.

b. Flanged

1) Ductile iron, ANSI A21.10.

2) Bolt Circles and Bolt Holes: Class 125.

3) Gaskets: 1/8 inch EPDM full faced.

c. Grooved

1) ANSI/AWWA C606

2) Grooved joint couplings shall consist of two or more ductile iron housings to ASTM A536.

3) Gaskets: FlushSeal pressure responsive gasket to ASTM D2000.

4) Housing: Ductile Iron with coal tar epoxy coating (min 3 mils).

5) Bolts and nuts: 316 SST.

6) Basis of Design: Victaulic Style 31.

d. Mechanical or Push-on

1) ANSI A21.11.

2) Gaskets: plain tipped.

e. Restrained

1) Provide restrained joints on all buried pipe joints.

2) Restraining wedges shall be made of ductile iron; conform to ASTM A536.

3) Restraint at pipe joints (≥ 24-inch):

a) TR Flex by US Pipe.

b) Super-Lock or Restrained Tyton Joint by Clow.

c) Flex-Ring or Lok-Ring by American Cast Iron Pipe Company.

4) Restraint at pipe joints (< 24-inch):

a) All products acceptable for pipe ≥ 24-inch

b) Flex-ring by US Pipe.

c) Lok-Ring by American Cast Iron Pipe Company.

3. Fittings
   a. Types: As shown on the Drawings—grooved fittings are acceptable at locations where flanged fittings are shown on the drawings. If not designated, use flanged fittings for exposed piping and mechanical fittings for buried pipe.
   b. Flanged: ANSI/AWWA C110/A21.10.
   c. Grooved
      1) Comply with ANSI A21.10 /AWWA C110 for center to end dimensions, and ANSI A21.10 /AWWA C110 or AWWA C153 for wall thickness, with ends to AWWA C606.
      2) Basis of Design: Victaulic AWWA Fittings.
   d. Mechanical joint
      1) Full body ANSI/AWWA C110/A21.10 or short body ANSI/AWWA C153/A21.53.
   e. Pressure rating: 250 psi minimum.
   f. Coating and lining: Identical to connecting piping.
   g. Base tees and bends: Drill and furnish with anchor bolts. Machine when used as pipe kicker.
   h. Restrained
      1) Provide restrained joints on all buried pipe fittings.
      2) Restraining wedges shall be made of ductile iron; conform to ASTM A536.
      3) Provide a full length of pipe on both sides of the fitting.
      4) Restraint at fittings and valves
         a) Megalug by EBAA Iron Sales.

D. Prestressed Concrete Cylinder Pipe (PCCP)
   1. Prestressed concrete cylinder pipe and fittings shall be manufactured by Thompson Pipe Group, Grand Prairie, TX or equal.
   2. Unless otherwise specified, the design materials and workmanship for pipe shall conform to the requirements of AWWA C301. Core and coating thickness for pipe shall be as specified in AWWA C301.
   3. Design Conditions
      a. Pipe shall be designed in accordance with the AWWA C304 Standard, using the following design conditions; these conditions shall also be used in designing fittings that include a Portland cement mortar interior and exterior coating of the steel cylinder:
      b. Pipe shall be designed for an external live loading, including impact, equal to AASHTO H-20 loading with earth cover as shown
      c. Service Conditions:
         1) Liquid Service: Water
         2) pH range of contents: 6.0 to 8.5
         3) Design working pressure: 40 psi.
         4) Design transient pressure: 56 psi.
         5) Field test pressure shall be 50 psi.
         6) Pipe overburden and trench bedding condition: as shown on Drawings.
   4. The pipe core shall be produced by the centrifugal method or the vertical casting method.
   5. Materials
      a. Cement shall be Type II and shall be in accordance with ASTM C150.
      b. Mortar coating shall consist of one part cement to a maximum of three parts fine aggregate by weight. Rebound not to exceed one fourth of the total mix weight may be used provided the rebound is treated as fine aggregate.

c. Wire shall be a minimum of No.6 gauge and shall meet the requirements of ASTM A648, Class III. Wire of a class strength greater than Class III will not be permitted.
d. Steel cylinders shall be No. 16 gauge minimum thickness and shall be hot rolled.

6. Fittings
   a. Steel thickness of all fittings shall be designed in accordance with Chapter 8 of the AWWA M9 Manual. Fittings shall be designed for the same conditions as the adjacent pipe.
   b. Fabrication of the fittings shall be as per AWWA M9 manual and C301.
   c. Interior and exterior concrete/mortar coating shall be as per AWWA C301.
7. Joints
   a. Bell and spigot joint rings shall be steel, self-centering type, and otherwise specified in AWWA C301. Surfaces of the joint rings that will be exposed after fabrication is complete shall receive a zinc metalized coating of 4 mils thickness (0.004").
   b. Provide restrained joints by field welding joints or by mechanically restrained joints.
   c. The rubber gaskets shall be in accordance with AWWA C301 and shall be designed and manufactured so that the completed joint will withstand an internal water pressure in excess of the highest pressure to which the pipe will be subjected without showing any leakage by the gasket or displacement of it.
   d. Bell and spigot wall fittings shall be the manufacturer's standard design. Wall fittings shall be supplied with adequate bracing to keep them round and true during transportation and installation.

E. PVC Pipe and Fittings
1. Pipe:
   a. Schedule 80.
   b. Provide standard lengths of pipe sizes 10-inch and larger, beveled at each end by the pipe manufacturer.
2. Material:
   a. Type I, Grade I (Class 12454) conforming to ASTM D 1784.
3. Nipples:
   a. Short nipples shall be the same as the PVC pipe.
4. Fittings:
   a. Fittings shall be schedule 80 and shall conform to ASTM D 2464 for threaded fittings 6-inches and smaller and ASTM D 2467 for socket-type fittings 8-inches and smaller. For threaded fittings larger than 6-inches and for solvent welded fittings larger than 8-inches the fittings shall be schedule 80 per the manufacturer's standards. All fittings shall successfully pass the required pressure test. All fittings shall be manufactured in the USA by an ISO 9002 manufacturer.
5. Flanges:
   a. PVC flanges shall be made of the same material as the pipe. Flanges shall match the bolt pattern of ANSI B16.5, Class 150. Flanges shall be flat face.
   b. Gaskets shall be full faced, low torque, molded EPDM with dual concentric, convex sealing rings (and PTFE bonded to the rubber). The dimensions shall comply with 150# ANSI B16.5 drilling.

6. Unions
    a. Unions shall have socket-type ends, EPDM o-rings (unless noted otherwise), and shall be schedule 80. Material shall be Type 1, Grade I (Class 12454) per ASTM D 1784.
    b. Provide Unions at connections to equipment, valves, and other accessories to facilitate equipment removal.
7. Joints
    a. Pipes less than 8-inch diameter:
        1) Pipe and fitting joints shall be socket welded.
        2) Screwed joints that are necessary to match up to threaded valves or fittings shall be made up with Teflon Tape only.
    b. Pipes 8-inch diameter and larger:
        1) Grooved Joints.
        2) Grooved joint couplings shall consist of two or more ductile iron housings to ASTM A536.
        3) Gaskets: EPDM (Grade E).
        4) Housing: Ductile Iron orange enamel coating.
        5) Bolts and nuts: 316 SST.
        6) Basis of Design: Victaulic Style 357 coupling with PGS-300 groove profile.
    c. Connections to valves, pumps, and equipment:
        1) Provide flanges. Flanged joints shall be made with solvent welded PVC flanges.
8. Solvent Cement:
    a. IPS Corporation Weld-On 724 without exception.
9. Threaded ends:
    a. Taper pipe threads. All threaded female fittings shall be 316 stainless steel reinforced.
10. Manufacturer
    a. Pipe: Harvel or equal.
    b. Fittings: Spears or equal.

F. Polyvinyl Chloride Pipe (PVC) C900
1. Pipe: Conform to AWWA C900.
2. Dimension Ratio: DR-14 (unless noted otherwise on Drawings).
3. Pressure Class: 300 psi (unless noted otherwise on Drawings).
4. Joints: Flexible elastomeric, conform to ASTM D3139.
5. Gaskets: Conform to ASTM F477.
6. Fittings: Fully restrained ductile iron.
7. PVC Resin: Meet or exceed cell class 12454 as defined in ASTM D1784.
8. Pipe shall be homogeneous throughout; free from voids, cracks, inclusions or other defects. Surfaces shall be free from nicks, scoring, scratches, and other blemishes.
9. Color: Green
10. Manufacturer/Product name: JM Eagle/Blue Brute or equal.

G. Polyvinyl Chloride Pipe (PVC) D3034/F679
1. Pipe: Conform to ASTM D3034/F679.
2. Dimension Ratio: DR-26 unless otherwise noted on Drawings.
3. Pressure Class: PS115 unless otherwise noted on Drawings.
4. Joints: Flexible elastomeric, conform to ASTM D3212.
5. Gaskets: Conform to ASTM F477.
6. PVC Resin: Meet or exceed cell class 12364 as defined in ASTM D1784.

7. Pipe shall be homogeneous throughout; free from voids, cracks, inclusions or other defects. Surfaces shall be free from nicks, scoring, scratches, and other blemishes.
8. Color: Green
9. Manufacturer/Product name: JM Eagle/Ring-Tite PVC Gravity Sewer or equal.

H. High Density Polyethylene (HDPE)
1. Pipe: Conform to AWWA C901/906.
2. Dimension Ratio: DR-17 (unless noted otherwise on Drawings).
3. Pressure Class: 125 psi (unless noted otherwise on Drawings).
4. Joints: Heat fusion per ASTM D2657.
5. Resin: PPI TR-4 PE 4710, per ASTM D3350 Cell Class 445574 C/E.
6. Color: Black with green stripes.
7. Manufacturer/Product name: JM Eagle or equal.

I. Dual Wall Corrugated High Density Polyethylene (DWC-HDPE)
1. Pipe: Conform to ASTM F2648.
2. Joints: Soil tight bell and spigot, conform to AASHTO M294, or ASTM F2306.
3. Gaskets: Conform to ASTM F477
4. Resin: Cell classification 435420C (ESCR Test Condition B), as defined in ASTM D3350 except carbon black content should not exceed 4%.
5. Manufacturer/Product name: Advanced Drainage Systems, Inc./N-12

J. Single Wall Corrugated High Density Polyethylene (SWC-HDPE)
1. Pipe: Conform to AASHTO M252.
2. Perforations: Conform to AASHTO M252 Class II.
3. Joints: Soil tight couplings, conform to AASHTO M252 or M294.
4. Fittings: Conform to AASHTO M252.
5. Gaskets: Conform to ASTM D1056 Grade 2A2.
6. Resin: Cell classification 424420C, as defined in ASTM D3350 except carbon black content should not exceed 4%.
7. Manufacturer/Product name: Advanced Drainage Systems, Inc./Single Wall Highway Pipe.

2.3 STAINLESS STEEL PIPE

A. All stainless steel pipe and fittings shall be fabricated from Type 304 stainless steel Schedule 10S sheet and plate.
1. Pipe
a. Pipe shall conform to ASTM A-312 and be die-formed or rolled true to dimension and round within the applicable ANSI Standard. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe.
b. Fittings shall conform to ASTM A-403-WP in accordance with B16.9.
c. Longitudinal seams on pipe and fittings shall be welded by the GTAW, PAW, FCAW, SAW, or the SMAW methods. Filler metal, if utilized, shall be of same composition or superior to the pipe and fittings material.
d. Weld deposit at the seams shall have a slight crown on both sides of the weld and no cracks or crevices shall be allowed. Excessive weld deposits, slag, weld spatter and projections into interior of pipe shall be removed by grinding. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16 inch.

e. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard.
f. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard. Roll or Cut grooved as appropriate to the pipe material, wall thickness, pressure, size and method of joining.
g. For pipe sizes 2" and smaller, ASTM A312, Schedule 10S, stainless steel pipe with plain ends may be used in applicable piping systems with Vic-Press couplings and fittings.
h. Schedule 5S and 10S stainless steel pipe shall be roll grooved using a Victaulic grooving tool equipped with RX roll sets, specifically designed for stainless steel pipe.

2. Fittings
   a. Fittings shall be butt weld type per ASTM-A-403WP and manufactured in accordance with ANSI B16.9. All fittings shall be of the same pressure rating and grade material as the pipe.
   b. Fittings three inches and smaller shall be threaded conforming to ASTM-A-182 forged, Class 3000# and manufactured to ANSI B16.11.
   c. Fittings for buried or submerged pipe larger than three inches shall be butt-welded, conforming to ASTM-A-403WP, same pressure rating and material as the pipe and manufactured to ANSI B16.9.
   d. Fittings for above ground or exposed pipe larger than three inches shall be butt-welded or flanged, conforming to ASTM A 403 WP.
   e. Grooved End Fittings:
      1) Fittings shall be manufactured of stainless steel conforming to ASTM A-403, WPW, WPW/S9, or CR/S9, or shall be fabricated from stainless steel pipe conforming to ASTM A312, with factory grooved ends. Fittings shall be type 316.
      2) For NPS 2-inch and smaller, Schedule 10S stainless steel pipe may be used with precision, cold drawn, austenitic stainless steel fittings, complete with elastomer O-ring seals and suitable for working pressure of 500 psig. Basis of Design: Victaulic Vic-Press for Schedule 10S pipe.

3. Joints
   a. Joints for pipes three inches and smaller shall be threaded, grooved or socket welded, same material as the pipe, 3,000 pound WOG, conforming to ANSI B16.11.
   b. Joints for buried or submerged pipe larger than three inches shall be butt-welded.
   c. Joints for aboveground or exposed pipe larger than three inches shall be grooved or butt-welded except where flanges or grooved end joints are shown on the Drawings.
   d. Grooved
      1) Couplings shall consist of two ASTM A536 ductile iron housings or ASTM A351, Grade CF8M, stainless steel housings.
      2) Rigid Type: Housing key shall engage the bottom of the groove. Victaulic Style 89 (DI) and Style 489 (SS).
         a) AGS series two-segment couplings with lead-in chamfer on housing key and wide-width FlushSeal gasket. Victaulic Style W89.
      3) Flexible: Victaulic Style 77S.
   e. Split Sleeve Couplings
      1) Couplings shall consist of a double-arched rolled stainless steel housing, with closure plates and two elastomer O-ring seals. Couplings shall be Victaulic Style 230S Non-Restrained (Depend-O-Lok ExE); 231S

Expansion (Depend-O-Lok FxE); and Style 232S Restrained (Depend-O-Lock FxF).

4. Flanges
   a. Provide weld-neck flanges conforming to ANSI B16.5 for piping three inches and smaller to connect to flanged valves, fittings, or equipment. Provide slip-on flanges for piping larger than three inches. Provide blind flanges at dead end connections and where shown on the Drawings.
   b. Flanges shall be Class 150 per ANSI B16.5
   c. Provide full-face gaskets for flat faced flanges. Provide ring gaskets for raised face flanges. Gaskets shall be composed of asbestos with rubber binder, 1/8-inch thick, Johns-Manville No. 60, John Crane Co. "Granite", or equal for high temperature air service and shall be constructed of EPDM for ambient temperature water service.

2.4 CHEMICAL FEED TUBING

A. Braid Reinforced PVC Tubing
   1. Chemically resistant, flexible, high-dimensional stability and long-term strength.
   2. Working Pressure: 100 psi min. at 70 degree F
   3. Fittings: Barbed type, made of polypropylene, fastened with 316 SST hose clamps.
   4. Support: Tubing to be supported by schedule 80 PVC carrier piping. See details on the drawings. Carrier piping to be supported hardware and in accordance with Division 40, Section “Pipe Supports”.
   5. Manufacturer
      a. Tubing: New Age Industries Nylobrade or Engineer Approved Equal.
      b. Fittings: New Age Industries Thermobarb or Engineer Approved Equal.
   6. Spare Tubing:
      a. For each size diameter tubing provided, Contractor shall provide 1,000 LF of spare tubing.

2.5 PROCESS PIPE INSULATION

A. Process piping insulation is required at the following locations:
   1. All above grade exterior process piping.

B. Pipe Insulation, Non-flexible:
   1. Techlite 379 Series with PVC film jacket.
   2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
   3. Apply to the following piping in thickness indicated:
      a. Process piping (40 – 60 deg F):
         1) 1-1/4 inch and smaller 1/2 inch
         2) 1-1/2 inch and larger 1 inch
      b. Process piping (below 40 deg F):
         1) 3/4 inch and smaller 1/2 inch
         2) 1 inch to 6 inch 1 inch
         3) 8 inch and larger 1-1/2 inch

2.6 PROCESS PIPE HEAT TRACING

A. Process piping shall be heat traced where indicated on the drawings. Heat tracing shall be in accordance with Division 40, Section “Process Piping Heat Tracing”.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Piping shall be installed in a manner to permit easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
2. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
3. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
4. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
5. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the runouts of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
6. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
7. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
8. Pipe size reductions shall be made with factory-fabricated eccentric reducers, concentric reducers, or reducing fittings and shall be installed not to cause pocketing or inhibit the flow of the material.
9. Install shut-off valves or cocks with unions on all connections to equipment and on each side of traps and control valves as required for ease of proper servicing and maintenance.
10. Unless otherwise indicated, the discharge from pressure-and temperature-relief valves and equipment drains shall be piped to the nearest floor or hub drain, installed with an approved air gap as required, and arranged for safe discharge.
11. No pipe shall penetrate any structural member without the written approval of the Engineer. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the Engineer.
12. Flanges and Gaskets
    a. Where forged steel flanges are to be bolted to cast iron flanges, a smooth or flat-face forged steel flange with a full-face gasket shall be used.
    b. All gaskets, other than teflon envelope or full-face, shall be of the flat ring type, with the outside diameter of the gasket extending to the edge of the bolts.
    c. Gaskets for all joints shall have an inside diameter equal to the outside diameter of the pipes on which they are to be used to ensure that no portion of the gasket will project into the ports of valves, pipe, or fittings.
    d. The dimensions of all gaskets shall conform to ANSI Standard B-16.21 for nonmetallic gaskets.
13. Provide flanged coupling adapters as necessary to accommodate ease of piping installation according to Contractor's layout plan.
14. Installation shall include all rough-in and final connections to equipment and services as provided in the Contract Documents, for the services and equipment to be functional.

B. Cross Connections and Interconnections: No devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply

and any source of nonpotable water such as a drainage system, a soil pipe, a waste pipe, or where the water may be chemically treated.

3.2 PIPE EXPANSION CONTROL: INSTALLATION

A. General
1. Install expansion loops or joints as required, to limit strain and movement of the piping.
2. All loops shall be cold sprung when installed.
3. Install conforming manufactured guides for each loop and joint to maintain the proper pipe alignment and minimize undue stresses on the piping and joints.
4. All mechanical joints and guides shall be installed in accordance with the Manufacturer's recommendations.
5. Install conforming manufactured pipe anchors at the midpoint between loops and joints. Installation and design shall be subject to the approval of the Engineer or Owner.
6. Manufacturer shall be held responsible for the proper capacity of the joints, with a minimum 25% allowance beyond the anticipated expansion and contraction in the piping.

B. Polyvinyl Chloride (PVC) Pipe: Provide expansion joints in straight piping runs over 50 feet and at least every 50 feet. Shall be Proco Series 261 or equal based on Chemical compatibility.

3.3 EXPOSED PIPING: INSTALLATION

A. General
1. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping and supports.
2. Painting of piping is specified elsewhere in the Contract Documents.
3. Install straight runs true to line and elevation.
4. Install vertical pipe plumb in all directions.
5. Install piping parallel or perpendicular to building walls. Piping at angles and 45 deg runs across corners shall not be accepted unless specifically shown.

B. Joints
1. General
   a. Make joints in accordance with the pipe Manufacturer's recommendations and the requirements below.
   b. Cut piping accurate and square. Assemble without forcing or springing.
   c. Ream all pipes and tubing to full inside diameter after cutting. Remove sharp edges on end cuts.
   d. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.
   e. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
   f. Thoroughly wire-brush, wipe clean and dry all spigot mating surfaces immediately before pipe is installed.
2. Threaded Joints
   a. Use standard righthand tapered full depth threads on steel piping.
   b. Apply before installation an approved joint compound to the male threads only.
   c. Leave three pipe threads maximum exposed at each connection.
3. Grooved Joints:
   a. Install in accordance with the manufacturer’s latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and

roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for Contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices are being followed. Contractor shall correct any deficiencies found.

4. Solder Joints
   a. Ream or file pipe to remove burrs.
   b. Clean and polish contact surfaces of joints
   c. Apply flux to both male and female ends.
   d. Insert end of tube full depth into fitting socket.
   e. Heat joint evenly.
   f. Form continuous solder bead around entire joint circumference.
5. Flanged Joints: Use hexagon head nuts and bolts. Assemble flanged joints with gaskets and gasket compounds in compliance with the applicable material specifications. Tighten flange bolts evenly.
6. Plastic Pipe Joints: Comply with Manufacturer's recommendations.

C. Unions
1. Install dielectric unions where dissimilar metals are connected except at bronze or brass valves installed in ferrous piping.
2. Provide a union downstream of each screwed end valve.
3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

D. Eccentric Reducers: Use eccentric reducers where shown and where air or water pockets would occur in mains because of reduction in pipe size.

E. Transitions between Types of Pipe: Provide all necessary adapters, specials and connector pieces when connecting different types and sizes of pipe or connecting pipe furnished by different Manufacturers.

F. Restraints, Supports and Thrust Blocks
1. Install restrained joints as shown, specified, recommended by Manufacturer, or otherwise required.
2. Provide concrete and metal cradles, collars, kickers, and blocks as indicated.

G. Expansion Coupling
1. Install expansion couplings in tension to facilitate their removal.
2. Set stretcher bolts for maximum allowable elongation of expansion coupling as recommended by the Manufacturer.

H. Adjustment: Adjust all parts and components as required to provide correct operation.

I. Hangers, Supports and Attachments: Installation: Refer to Division 40 Section "Pipe Supports".

J. Identification of Piping: Paint, identify contents of piping and flow direction, and coordinate color coding of both insulated and non-insulated piping with Division 09 Section "High Performance Coatings".

3.4 BURIED PIPING: INSTALLATION

A. Conform to the applicable requirements set forth in Division 33 Section "Buried Piping Installation".

3.5 PVC AND CPVC PIPE INSTALLATION

A. General
1. Do not install pipe when the temperature is below 40 deg F or above 90 deg F. Store loose pipes on racks with a minimum support spacing of 3 feet. Provide shade from direct sunlight for pipe stored outdoors or installed outdoors until the pipe is filled with water.
2. Store fittings indoors in their original cartons.
3. Store solvent cement indoors or, if outdoors, shade from direct sunlight. Do not use solvent cements which have exceeded the shelf life marked on the storage container.
4. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section as a complete cylinder.

B. Installation
1. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it.
2. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings.
3. Bevel solvent welded pipe ends as recommended by the pipe manufacturer.

C. Solvent Welded Joints
1. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air for at least one hour to the same temperature conditions as the pipe.
2. Wipe away loose dirt and moisture from the ID and OD of the pipe end and the ID of the fittings before applying solvent cement. Do not apply solvent cement to wet surfaces.
3. Make up solvent welded joints per ASTM D 2855.
4. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads or pressures.

D. Flanged Joints
1. Lubricate stainless steel bolt threads with specified materials before installation.
2. Tighten bolts on flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be as shown in the following table:

Pipe Size (inches)	Final Torque (Ft-Lb)
1/2 – 1-1/2	10-15
2-4	20-30
6-8	33-50
10	53-75
12	80-110
14-24	100

E. Threaded Joints
   1. Cut threaded ends on pipe to the dimensions of ANSI B2.1. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe holddown methods, saw cutting blade size, and saw cutting speed.
   2. Pipe or tubing cutters shall be specifically designed for use on plastic pipe.
   3. If the holddown vise is used when pipe is cut, insert a rubber sheet between the vise jaws and the pipe to protect from scratching the pipe.
   4. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.
   5. Not more than three threads shall remain exposed after installation.
   6. All joints shall be wrapped with Teflon tape.

3.6 SLEEVES: INSTALLATION

A. Provide and accurately locate all sleeves required under this Section. Set sleeves true to line, grade and position, plumb or level, and maintain as such during the work under other Divisions.

B. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.

C. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done as Work of this Section, with no change in the Contract Sum or the Date of Substantial Completion.

D. Sleeves shall not penetrate any structural member except as shown on the Drawings.

E. Provide 8-inch clear space between sleeves unless otherwise indicated on the Drawings.

F. Sleeves shall be of the full thickness, with the exposed ends flush and smooth, with the structure in which they are installed.

G. Wherever water might get into the sleeve, the sleeves shall extend 1 inch above the finished surface and be made watertight. The exposed end shall be smooth and neatly finished.

H. On all piping passing through a sleeve, the piping insulation shall be continuous through the sleeve. The sleeve shall be sized to allow a 1 inch annular space between the sleeve and the bare pipe or insulation.

I. Sealing of Sleeves and Penetrations
   1. Where sleeves are embedded through cast-in-place concrete walls or slabs on or below grade, the joints between the concrete and the sleeve shall be sealed with a polyurethane sealer.
   2. Where sleeves pass through boxed out or cored openings in concrete walls or floor slabs on or below grade, a bonding agent shall be applied to the concrete surface and a nonshrink grout shall be installed between the concrete and the sleeves. After the grout has cured, the joints between the grout and the sleeves on both sides of the wall or floor shall be sealed with a polyurethane sealer.
   3. Where sleeves pass through exterior building walls above grade, the joints between the wall and sleeve on both sides of the wall shall be sealed with silicone sealer or the opening shall be sealed with silicone foam.

J. The 1 inch annular space around pipes passing through sleeves shall be filled with silicone foam having a minimum service temperature rating at least 15 deg F higher (8.3 deg C higher) than the temperature of the pipe service passing through it.

3.7 TESTING

A. General
1. All pipe lines shall be tested to prove tightness of the final assembly. The Engineer shall be given 24 hours notice before each test.
2. All tests required by governing authorities shall be satisfactorily made.
3. Provide all necessary testing apparatus, including gages, pumps, hoses, and fittings.
4. Repair and retest pipelines which fail to hold specified test pressure or which exceed the allowable leakage rate.
5. Test pressures specified apply at the lowest elevation of the pipeline section being tested unless otherwise noted.
6. The Contractor is responsible for all testing and shall pay all costs incurred during the specified testing.

B. Hydrostatic Pressure Testing
1. General
   a. Conduct hydrostatic pressure testing on all process piping in accordance with AWWA C600.
   b. Slowly fill section to be tested with water and expel all air. Install corporation cocks as necessary to remove air.
   c. Apply test pressure for two hours.
2. Exposed Piping
   a. Allow any concrete which may be affected by the testing to reach design strength before testing.
   b. Ensure that all supports and restraint protection are securely in place.
3. Buried Piping
   a. Place and compact backfill to at least the pipe centerline before testing, unless otherwise required or acceptable to the Engineer. Backfill and compact around all blocking before testing and as required to assure restraint by harnessed joints.
   b. Allow concrete for blocking to reach design strength before testing.
4. Test Pressure
   a. Piping connected to pump suction and discharge: 150% of specified maximum operating head of pump.
   b. Gravity flow ductile iron pipe: 150% of maximum static water head of pipe section being tested.
   c. Liquid chemical feed piping: 100 psi

C. Allowable Leakage: Leakage shall not exceed:

$$L = \frac{SD(P)^{0.5}}{133{,}200}$$

Where
L = Allowable leakage, gallons per hour.
S = Length of pipe tested, feet.
D = Nominal diameter of pipe, inches.
P = Average test pressure, psig.

3.8 CLEANING AND DISINFECTION

A. General
   1. All piping systems shall be cleaned and flushed out prior to operation. If it is necessary to place the system in operation by sections, then the cleaning shall be done by sections. Notify Owner prior to start of Work.
   2. Inspect inside of piping 24-inch diameter and larger and remove all debris, dirt and foreign matter.
   3. All piping, including equipment installed in connection with the piping, conveying liquids shall be filled and flushed several times to eliminate all debris and contaminants.
   4. Where pumps are installed, install temporary strainers ahead of pumps and circulate the medium through several cycles. The system shall be flushed out and the temporary strainers removed. Strainers shall have a free area of at least 3 times the cross sectional area of the attached pipe.
   5. Prior to turning over the Work, this Contractor shall remove and clean all strainers, traps, and dirt pockets.
   6. All process piping shall be pigged and flushed.

B. Disinfection
   1. Standard: AWWA C651 unless otherwise acceptable to the Engineer or Owner.
   2. Disinfect all potable water piping.
   3. Flush piping with water at 2-1/2 feet per second minimum velocity prior to disinfection.
   4. Water for flushing, testing and chlorination will be furnished by Owner at no cost to Contractor.
   5. Chlorine shall be supplied by Contractor.
   6. All other labor, material and equipment including chlorination taps and blow-off taps shall be furnished and paid for by the Contractor.
   7. Chlorine Concentration
      a. Maintain chlorine concentration between 50 and 100 parts per million for water entering the pipe.
      b. 25 parts per million minimum residual concentration shall remain after 24 hr retention period.
      c. Repeat the operation as necessary to provide complete disinfection.
      d. Provide two safe total coliform samples taken 24 hours apart prior to placing pipe in service. Provide results to Ohio EPA and the Engineer.

3.9 INSULATION INSTALLATION

A. Do not insulate piping until satisfactory completion of required pressure tests.

B. Apply insulation to clean, dry surfaces with pipe surfaces at room temperature.

C. Butt insulation firmly together with longitudinal and end joints sealed with compatible jackets, facings and adhesives as specified.

D. Apply adhesives, mastics and coatings per manufacturer's recommendations and as specified.

E. On cold surfaces where vapor barrier jackets are used, apply insulation with a continuous, unbroken vapor seal.
   1. Adequately insulate and vapor seal hangers, supports, and anchors that are secured directly to cold surfaces to prevent condensation.

F. Continue insulation through sleeves and wall and ceiling openings except insulation shall not continue through fire-rated (2-hour or greater) partitions, walls, floor-ceiling systems.

G. Insulate all fittings, valve bodies, flanges and other pipeline accessories.

H. At hangers and bracing, install in accord with Division 40 Section “Pipe Supports”.

I. Contractors shall consult manufacturer's Technical Bulletins for detailed information on safety precautions in using all insulation products, polyurethanes, polyisocyanurates, and related materials. The data shall describe fire and other risks, safety in handling, toxicity, threshold limit values, physiological effects of inhalation and eye and skin contact, incompatibilities and other essential information regarding use. Obtain 6 copies for distribution and use at jobsite and for submittal with shop drawing submittals.

J. On piping, install with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge on hot piping.
   1. On cold piping, use self-sealing lap system or adhesive applied to both surfaces per manufacturer's recommendation.
   2. Do not staple cold piping.
   3. Butt adjoining sections of insulation tightly together and continue jacket by installing self-adhering butt strips over entire circumferential joint.

K. Installation of Insulation of Fittings
   1. For pipe sizes 2 inches and smaller, finish with mineral fiber cement to thickness of adjoining pipe insulation.
   2. Over 2 inches, insulate with mitered pipe insulation segments or preformed fiberglass fittings secured with vinyl faced insulation strapping tape or 20 ga galvanized annealed wire and finished with one coat of mineral fiber cement.
   3. After cement is dry, finish with Glass Fab and seal with Foster 30-36 adhesive.
   4. Prefabricated fitting covers approved for use at pipe fittings may be used instead of finishing method outlined above.
   5. Install in accordance with manufacturer's recommendations.

L. Cover all insulated piping exposed to weather with additional jacket of 0.016-inch smooth aluminum with moisture barrier.
   1. Apply aluminum jacket with 0.020-inch x 3/8-inch aluminum bands on 9-inch centers, minimum 2-inch lap joint.
   2. Protect fittings, valves, and specialties exposed to weather in like manner.
   3. Contractor option: Use Ceel-Co 300 Series plastic jacketing applied per manufacturer's recommendations.

M. Reinforce jackets on insulated piping in mechanical rooms and central plant less than 8 ft. above floor.
   1. Cover with 0.030 inch PVC jacket conforming to 25-50 fire requirements.

END OF SECTION 40 0513

SECTION 40 0523

PROCESS VALVES, GATES, AND ACCESSORIES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the Work of this Section, including, but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Valves, Gates, Actuators and Accessory Process Equipment

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Valves and accessories for a specific system, as covered in other sections. Valves not included in other Sections shall conform to this Section.

B. Valves associated with plumbing, interior potable water systems and heating normally installed by a mechanical contractor.

C. Division 09 Sections.

D. Division 26 - Electrical.

1.4 QUALITY ASSURANCE

A. The equipment manufacturer shall have been engaged in the manufacture of the equipment being supplied for the past 5 years.

B. All equipment shall be rated for the specified test pressure of the piping where it is connected. Refer to Division 40 Section “Process Piping”, for test pressures.

C. Manufacturer's Representative
   1. A manufacturer-trained and certified representative shall check the installation, supervise the initial start-up and operation, and instruct the Owner's personnel in the proper operation and maintenance for the valves listed below.
      a. Pneumatic pinch valves.
      b. Electrically activated butterfly valves.
   2. The manufacturer's representative shall spend a minimum of 8 hours on site performing these services.
   3. Return visits shall be made as required to accommodate the construction schedule until each valve is started and demonstrated to be operating properly. Return visits shall be at no expense to the Owner.

1.5 SUBMITTALS

A. Provide technical submittals in accordance with Division 01 Section “Submittal Procedures”, demonstrating that all equipment provided conforms completely to the requirements of this Section.

B. Product Data
   1. Catalog cut sheets and description of all items.
   2. Specific location of each item in the Project identified with Engineer's valve schedule number.
   3. Construction materials.
   4. Electric and control data.

C. Shop Drawings
   1. Detailed dimensional drawings indicating overall dimensions and required clearances of each size item with actuators mounted.
   2. Orientation of actuator.
   3. Elevations, weights and sizes of all gates.
   4. Cross-section drawings labeling all interior parts, including bearings, seals, and other mechanical parts.
   5. Diagrams indicating lubrication compartments and anchoring and mounting details.

D. Operation and Maintenance Manuals: Provide Operation and Maintenance Manuals in accordance with Division 01 Section “Closeout Procedures”.

1.6 HANDLING, DELIVERY AND STORAGE

A. Handling and storage instructions shall accompany each pump delivered to the site. Store all equipment in accordance with the manufacturer's instructions.

B. Power actuators shall be stored indoors, protected from precipitation.

1.7 REFERENCED STANDARDS

A. American Society of Mechanical Engineers (ASME); American Society of Testing and Materials (ASTM); American Water Works Association (AWWA).

PART 2 - PRODUCTS

2.1 AMERICAN IRON AND STEEL REQUIREMENTS

A. This project is being funded in part with loan and loan forgiveness funds from the Ohio EPA WSRLA Program and is subject to American Iron and Steel (AIS) requirements. See Division 00, Section “OEPA WSRLA Program Requirements.”

B. Attempts made by suppliers and/or manufacturer’s to intentionally avoid having to comply with the AIS requirements by changing the material of valve components from those specified (or other similar measures) will result in the submittal being returned with the disposition of Does Not Conform.

2.2 GENERAL

A. Valve schedule is shown on the drawings.

B. Connections: As shown on the Drawings, grooved joints are acceptable at locations where flanged joints are shown on the drawings. If not designated, use flanged or grooved joints for exposed valves and mechanical joints for buried valves.
   1. Flanged: ANSI B16.1, Class 125
   2. Mechanical joint: ANSI 21.11
   3. Grooved: ANSI/AWWA C-606

C. Bolts and Studs
   1. Exposed (painted): Zinc Plated.
   2. Exposed (unpainted): 304 SST.
   3. Buried: 316 SST or Cor-Blu.
   4. Submerged: 316 SST.
   5. Head: Hexagon for flanged, T-head for mechanical joint.
   6. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the bolts.
   7. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.

D. Labeling
   1. Manufacturer's name and working pressure cost in raised letters on valve body.
   2. Valve Tags: Provide 316 SST valve tags on each valve after valve is installed, with the following information clearly labeled:
      a. Valve number
      b. Direction to open
      c. Number of turns to open
      d. Pressure rating
      e. Function

2.3 VALVES

A. Butterfly Valve (BFV-AWWA)
   1. Description:
      a. AWWA C-504 type butterfly valve.
   2. Manufacturer/Model:
      a. Dezurik/BAW.
      b. Crispin.
      c. Pratt.
      d. Val-Matic.
   3. End Connection:
      a. Flanged, ANSI Class 150.
   4. Materials of Construction:
      a. Body:
         1) Cast Iron, ASTM A126 Class B
      b. Discs
         1) Cast 316 SST, ASTM A749, Type CF8M
      c. Shaft, Seating Edge, and Pin:
         1) 316 SST, ASTM A276
      d. Packing and Seat:
         1) EPDM.
      e. Torque Screw:
         1) 316 SST, ASTM A276

f. Set Screws:
1) 18-8 SST.
g. Plug:
1) Malleable Iron, ASTM A47-52 Grade 35018
h. Lower Journal Bearing:
1) PTFE

5. Valve Orientation
a. Any butterfly valve located immediately downstream of the discharge of any centrifugal pump with a vertical drive shaft shall have its shaft in a horizontal position.
b. Any butterfly valve located immediately downstream of the discharge of any vertical lift type pump should have its shaft in a vertical position.
c. Any butterfly valve which is located immediately downstream of any elbow should have its shaft located in the same plane as the elbow.
d. The valve disc should be installed with the shaft axis oriented so nonsymmetric profiles caused by pump discharge, elbows, or other causes of irregular flow do not impinge upon the valve disc in a nonsymmetrical manner about the valve shaft axis.

B. Butterfly Valve (BFV-SST)
1. Description:
a. Double offset stem and disc, high performance butterfly valve with zero leakage bi-directional shutoff to full rated pressure.
2. Manufacturer/Model:
a. Bray/Series 40.
b. Dezurik/BHP.
c. Engineer Approved Equal.
3. End Connection:
a. Wafer or Lug, ANSI Class 150
4. Pressure Rating:
a. 275 psig at Temperatures up to 100 degrees F
5. Materials of Construction:
a. Body and Disc:
1) Cast 316 SST, ASTM A351 GR CF8M
b. Stem and Taper Pins:
1) 17-4 PH SST, ASTM A564-Type 630
c. Disc Spacers, Bearing Assembly, Gland Ring, and Stud:
1) 316 SST, ASTM 276 with TFE and glass fabric bearing assembly liner
d. Gland Retainer and Seat Retainer Plate:
1) Cast 316 SST, ASTM A351 GR CF8M
e. Lock Washers, Hex Nut, Cap Screws, and Mounting Plate:
1) 18-8 SST
f. Gasket (between bearing assembly and locator plug):
1) PTFE

C. Butterfly Valve (BFV-Coated)
1. Description:
a. Resilient seat, high strength, one piece butterfly valve with coated disc and bi-directional bubble-tight shutoff.
2. Manufacturer/Model:
a. Bray/Series 30.

b. Dezurik
c. Engineer Approved Equal.

3. End Connection:
   a. Wafer or Lug, ANSI Class 150
4. Pressure Rating:
   a. 175 psig at Temperatures up to 100 degrees F
5. Materials of Construction:
   a. Body:
      1) Cast Iron, ASTM A126 Class B with Nylon 11 Coating
   b. Seat:
      1) EPDM
   c. Stem:
      1) 416 SST, ASTM A582
   d. Disc:
      1) Nylon 11 Coated Ductile Iron

D. Swing Check Valve (CV-Cast Iron)
1. Description:
   a. AWWA C-508 type check valve.
2. General:
   a. The valve shall be tight seating when closed, and when open provide full flow area through the valve equal to the pipeline diameter.
   b. The seating shall be by a resilient field replaceable ring on the valve disc contacting a stainless seat ring in the valve body.
   c. Valve shall be capable of being installed in the vertical.
   d. Valve shall include an air cushion closure control device.
3. Manufacturer/Model:
   a. APCO/CVS.
   b. Bray.
   c. Pratt.
4. End Connection:
   a. Flanged, ANSI Class 150.
5. Materials of Construction:
   a. Body, cover, disc, and disc arm:
      1) Ductile Iron ASTM A536 or Cast Iron A126 C1B.
   b. Body Seat:
      1) 316 SST with EPDM retaining ring.
   c. Seat retaining ring:
      1) 304 SST.
   d. Disc Seat:
      1) EPDM.
   e. Pivot Shaft:
      1) Type 303 SST, ASTM 582.
   f. Studs, bolts, nuts:
      1) 304 or 316 SST.

E. Check Valve (CV-SST)
1. Description:
2. Manufacturer/Model:
   a. Bray(Rite)/210.
   b. Prince.

c. Engineer Approved Equal.

3. End Connection:
   a. Wafer or Lug, ANSI Class 150
4. Materials of Construction:
   a. Body:
      1) Cast 316 SST, ASTM A351 GR CF78M
   b. Seat:
      1) EPDM
   c. Spacers:
      1) 316 SST, ASTM A479

F. Globe Valve (GLOBE-Conc.)
1. Manufacturer:
   a. Warren Controls, 5840 Series.
2. Function:
   a. Flow Control.
3. End Connection:
   a. Flanged, ANSI Class 300.
4. Materials of Construction:
   a. Body and Bonnet:
      1) Cast 316 SST (ASTM A351 GR CF8M)
   b. Stem, cage, plug, trim, and seat ring:
      1) 316 SST
   c. Lip:
      1) EPDM with PEEK bearings
5. Enclosure Blanket:
   a. Provide an insulating blanket wrap for the valve
6. Actuator:
   a. Type:
      1) Modulating, linear, industrial electrically actuated.
   b. Fail in place.
   c. Power Supply:
      1) 24 VAC/DC.
   d. Control Signal and Feedback:
      1) 4-20 mA.
   e. Cover:
      1) Polycarbonate
   f. Gear case material:
      1) Aluminum die casting, powder-coated (60 micron thickness)
   g. Enclosure Rating:
      1) IP65

G. Globe Valve (GLOBE-Bypass)
1. Description: Motor operated flow control valve.
2. Manufacturer/Model:
   a. Ross Valve
   b. Cla-Valve
   c. GA Industries
3. End Connection:
   a. Flanged, ANSI Class 150.
4. Pressure Rating: 250 psi.

5. Materials of Construction:
    a. Body and cover:
        1) Ductile Iron, ASTM A536.
    b. Disc Retainer & Diaphragm Washer:
        1) Cast Iron
    c. Disc Guide, Seat, and Cover Bearing:
        1) Bronze, ASTM B62.
    d. Disc and Diaphragm:
        1) Buna-A (with nylon reinforcement in the diaphragm).
    e. Stem, Nut, and Spring:
        1) 304 SST.
6. Controls
    a. Provide a modulating motorized operator for control of the valve via a 4-20 mA signal.

H. V-notch Ball Valve (BA-V-Notch)
1. Manufacturer/Model
    a. Bray(Flow-tek)/V-Control
    b. Dezurik.
2. End Connection:
    a. Flanged, ANSI Class 150.
3. Materials of Construction:
    a. Body, Ball, and Stem:
        1) 316 Stainless Steel.
    b. Seals and Seats:
        1) Tek-Fil.
4. Actuator: As specified in the valve schedule.

I. Ball Valve (BA-SST)
1. Description:
    a. One piece body, quarter turn, bottom entry blowout proof stem, SST ball valve.
2. Manufacturer/Model:
    a. Bray(Flow-Tek)/S40
    b. Engineer Approved Equal
3. End Connection:
    a. NPT Threaded
4. Pressure Rating:
    a. 1,000 psi WOG
5. Materials of Construction:
    a. Body and Body Insert:
        1) Cast 316 SST, ASTM A351 GR CF8M
    b. Ball and Stem:
        1) 316 SST, ASTM A479
    c. Seat, Thrust Washer, Stem Packing
        1) RPTFE
    d. Spring Washer:
        1) 301 SST
    e. Handle, Handle Nut, Locking Device, and Gland
        1) 304 SST
    f. Handle Sleeve
        1) Vinyl

J. Check Valve (CV-Thermoplastic)
   1. Description: Solid, thermoplastic construction type wafer check valve incorporating a single disc design suitable for either horizontal or vertical installations.
   2. Manufacturer/Model
      a. Asahi/Wafer Check Valve.
      b. Engineer Approved Equal.
   3. End Connection:
      a. Wafer, ANSI Class 150.
   4. Pressure Rating:
      a. 150 psig (85 psi for valves larger than 8")
   5. Materials of Construction:
      a. Body, Disc, Stopper, Shaft, Shaft Plug, and AV Bolt:
         1) H707 PVC, ASTM D1784 1245
      b. I-bolt:
         1) SS400.
      c. Spring:
         1) SWP-B W/ETFE Coating.
      d. O-ring:
         1) EPDM

K. Butterfly Valve (BFV-Thermoplastic)
   1. Description: Thermoplastic construction type butterfly valve with full seat liner design fully molded around the body.
   2. Manufacturer/Model
      a. Asahi/Type 57P.
      b. Engineer Approved Equal.
   3. End Connection:
      a. Wafer, ANSI Class 150.
   4. Pressure Rating:
      a. 150 psig (100 psi for valves larger than 10")
   5. Materials of Construction:
      a. Body, Disc, Seat Bush:
         1) H707 PVC, ASTM D1784 1245A
      b. Seat, O-ring, and Gasket:
         1) EPDM.
      c. Stem:
         1) 316 SST.
      d. Screw and Bolt:
         1) 304 SST.

L. Ball Valve (BA-Thermoplastic)
   1. Description: Thermoplastic construction type, true union ball valve with two-way blocking capability.
   2. Manufacturer/Model
      a. Asahi/Type 21/21A.
      b. No Approved Equals.
   3. End Connection:
      a. True Union.
   4. Pressure Rating:
      a. 230 psig (150 psi for valves larger than 3") up to temperatures of 70 degrees F
   5. Vent Hole:

a. Provide valves equipped with 1/8-inch vent holes for all sodium hypochlorite (NaOCl) applications.

6. Materials of Construction:
   a. Body, Ball, Carrier, End Connector, union Nut, and Stem:
      1) H707 PVC, ASTM D1784 1245A
   b. Seat:
      1) PTFE.
   c. O-rings:
      1) EPDM (water service).
      2) PTFE (chemical service).
   d. Stop Ring:
      1) PVDF.
   e. Handle:
      1) ABS
   f. Ring:
      1) 304 SST

M. Diaphragm Valve (DV-Thermoplastic)
1. Description: Thermoplastic construction type, diaphragm valve.
2. Manufacturer/Model
   a. Asahi Type 14.
3. End Connection:
   a. True Union.
4. Pressure Rating:
   a. 150 psi up to temperatures of 105 degrees F
5. Materials of Construction:
   a. Body, Bonnet, Carrier, and Union Nut:
      1) PVC
   b. Diaphragm and Cushion:
      1) EPDM.
   c. O-rings:
      1) EPDM.
   d. Handwheel:
      1) Polypropylene
   e. Screw:
      1) 304 SST

N. Check Valve (CV-Thermoplastic)
1. Description: Thermoplastic construction type, ball check valve.
2. Manufacturer/Model
   a. Asahi Type 14.
3. End Connection:
   a. True Union.
4. Pressure Rating:
   a. 150 psi up to temperatures of 120 degrees F
5. Materials of Construction:
   a. Ball, Body, End Connector, Union Nut, and Stop Ring:
      1) PVC
   b. Diaphragm and Cushion:
      1) EPDM.
   c. Seat and O-rings:

1) EPDM (water service).
2) PTFE (chemical service).

O. Overflow Check (CV-Overflow)
1. Description: Wafer style, full face check valve.
2. Manufacturer/Model
a. Tideflex Waterflex.
3. End Connection:
a. Flanged.
4. Pressure Rating:
a. 50 psi.
5. Materials of Construction:
a. Disc:
1) 304 SST.
b. Waterflex Membrane:
1) EPDM.

2.4 AIR RELEASE VALVES

A. Combination Air Valve (CAV)
1. Description:
a. AWWA C-512 combination air/vacuum valve.
2. General:
a. The CAV shall be designed to allow large quantities of air to escape out the orifice when filling a pipeline and to close water tight when the liquid enters the valve. The Air/Vacuum Valve shall also permit large quantities of air to enter through the orifice when the pipeline is being drained to break the vacuum. The discharge orifice area shall be equal or greater than the inlet of the valve.
b. The valve shall consist of a body, cover, baffle, float and seat. The baffle will be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely. The seat shall be fastened into the valve cover without distortion and shall be easily removed, if necessary. The float shall be stainless steel, and shall be center guided into the seat.
3. End Connection:
a. NPT Threaded.
4. Materials of Construction:
a. Body and Cover:
1) ASTM A126 Gr.B Cast iron or ASTM A536 Gr 65-45-12 Ductile Iron.
b. Float:
1) 304 SST.
c. Seat:
1) Buna-N.
5. Rated Pressure: 175 psi.
6. Manufacturer/Model:
a. DeZURIK (APCO)/AVV.
b. GA
c. Crispin
d. VAL-MATIC
7. All CAVs shall include a SST ball valve for isolation. Contractor shall field route drain piping for CAV to the nearest floor or trench drain. Piping from host pipe to CAV shall be SST, pipe from ARV to drain shall be SCH 80 PVC.

B. Air Release Valve (ARV)
   1. Description:
      a. AWWA C-512 combination air valve.
   2. General:
      a. Float operated and shall incorporate a simple lever mechanism to enable the valve to automatically release accumulated air from a fluid system while that system is pressurized and operating.
   3. End Connection:
      a. NPT Threaded.
   4. Materials of Construction:
      a. Body and Cover:
         1) ASTM A126 Gr.B Cast iron or ASTM A536 Gr 65-45-12 Ductile Iron.
      b. Float, seat, needle, linkage, all other internals, and hardware:
         1) 304 SST.
   5. Rated Pressure: 175 psi.
   6. Manufacturers:
      a. DeZURIK (APCO)/ARV.
      b. GA
      c. Crispin
      d. VAL-MATIC
   7. All ARVs shall include a SST ball valve for isolation. Contractor shall field route drain piping for ARV to the nearest floor or trench drain. Piping from host pipe to ARV shall be SST, pipe from ARV to drain shall be SCH 80 PVC.

2.5 ACTUATORS - MANUAL

A. Type: Hand-wheel, lever, chain-wheel, chainlever or operating nut.

B. Location
   1. Hand-wheel or Lever: Comply with Schedules
   2. Chain-wheel or Chainlever: All valves with centerline more than 6'-0" above the operating floor level.
   3. Operating Nut: 2 inch square, all buried valves unless otherwise specified in Schedules

C. Gearing
   1. Refer to individual valve specification.
   2. Location: All valves requiring operating torque in excess of that provided by maximum pull of 80 lb on hand-wheel or chain-wheel or maximum input of 150 ft lb on operating nuts.
   3. Design: Totally enclosed.

D. Chain-Wheel Operator Details
   1. Chain-Wheel: Manufacturer's standard design or sprocket wheel bolted directly to valve hand-wheel.
   2. Chain Length and Size: Provide aluminum alloy chain for all chain-wheel-operated valves. Length of chain shall be such that chain comes within 3'-6" of the floor.
   3. Chain-Hold Device: Equip each operator with 1/2-inch hook bolt located to hold chain from walking area.

E. Additional Butterfly Valve Operator Details
   1. Stop-limiting Devices: Provide for open and closed position.

2. Design: Adequate to avoid damage to all components from 200 lb pull on hand-wheel or chain-wheel operators, or 300 ft lb input torque on operating nuts.
3. Comply with all applicable AWWA standards.

2.6 ELECTRIC ACTUATORS - MODULATING

A. All electric actuators shall conform to the requirements of AWWA C-542.

B. All actuators shall be multi-turn type with gearbox, suitable for modulating service.

C. Refer to the valve schedule for service conditions.

D. Actuators shall contain motor, gearing, manual over-ride, limit switches, torque switches, drive coupling, integral motor controls, position feedback transmitter, and digital position indicator.

E. Motor
1. Designed for actuator service.
2. Induction type.
3. Insulation: Class H.
4. Protected by thermal switches imbedded in the motor windings.
5. Totally enclosed, non-ventilated.
6. Voltage: As indicated on the electrical drawings.

F. Actuator and Gearbox Enclosure:
1. Valves inside tanks, vaults, trenches, or other submersible locations: IPS 68.
2. All other locations: NEMA 4X.

G. External Fasteners
1. Stainless steel.
2. Fasteners on terminal compartments shall be captured to prevent loss while cover is removed.

H. Gearing
1. Oil-lubricated.
2. Designed to withstand full stall torque of the motor.

I. Manual Operation
1. Manual over-ride shall be by handwheel.
2. Manual operation shall be via power gearing.
3. Return from manual to electric mode of operation shall be automatic upon motor operation.
4. A seized or inoperable motor or power gearing shall not prevent manual operation.
5. Manual operation shall be possible with electric components removed.

J. Limit Switches
1. Limit switches shall be furnished at each end of travel.
2. Switch adjustment shall not be altered by manual operation.
3. Switches shall be capable of quick adjustment without removing covers.
4. Furnish two sets of normally open and two sets of normally closed contacts at each end of travel. Contacts shall be capable of reliably switching low voltage DC source from the control system.

K. Torque Switch
   1. Furnish torque switch at each end of travel.
   2. Switch shall trip when the valve load exceeds the switch setting.
   3. Switch adjustment device shall be calibrated directly in percent of torque.

L. Wiring: Wiring shall be terminated at a separately sealed terminal compartment.

M. Temperature Range: Actuator shall be capable of operating in an ambient temperature range of –20 to +160 deg F (with motor controls).

N. The required dynamic valve torque shall be no more than 60% of the electric actuator's maximum rated breakaway torque. Power gearing shall have zero backlash between the motor and actuator output.

O. All actuators shall be provided with the following:
   1. Feedback potentiometer.
   2. Reversing starter.
   3. Control transformer.
   4. Phase rotation correction.
   5. Monitor relay.
   6. Positioner capable of accepting a 4-20 mADC command signal and positioning the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field adjustable to fail to the open, closed, or last position on loss of signal.
   7. "Open – Close" pushbuttons.
   8. "Local – Off – Remote" selector switch.
   9. Red and green indicating lights or LED's.

P. Manufacturer: AUMA.

2.7 ELECTRIC ACTUATORS – FOR ON/OFF SERVICE

A. All electric actuators shall conform to the requirements of AWWA C-542.

B. All actuators shall be multi-turn type with gearbox, suitable for modulating service.

C. Refer to the valve schedule for service conditions.

D. Actuators shall contain motor, gearing, manual over-ride, limit switches, torque switches, drive coupling, integral motor controls, and digital position indicator.

E. Motor
   1. Designed for actuator service.
   2. Induction type.
   3. Insulation: class H.
   4. Protected by thermal switches imbedded in the motor windings.
   5. Totally enclosed, non-ventilated.
   6. Voltage: As indicated on the electrical drawings.

F. Actuator and Gearbox Enclosure:
   1. Valves inside tanks, vaults, trenches, or other submersible locations: IPS 68.

2. All other locations: NEMA 4X.

G. External Fasteners
1. Stainless steel.
2. Fasteners on terminal compartments shall be captured to prevent loss while cover is removed.

H. Gearing
1. Oil-lubricated.
2. Designed to withstand full stall torque of the motor.

I. Manual Operation
1. Manual over-ride shall be by handwheel.
2. Manual operation shall be via power gearing.
3. Return from manual to electric mode of operation shall be automatic upon motor operation.
4. A seized or inoperable motor or power gearing shall not prevent manual operation.
5. Manual operation shall be possible with electric components removed.

J. Limit Switches
1. Limit switches shall be furnished at each end of travel.
2. Switch adjustment shall not be altered by manual operation.
3. Switches shall be capable of quick adjustment without removing covers.
4. Furnish two sets of normally open and two sets of normally closed contacts at each end of travel. Contacts shall be capable of reliably switching low voltage DC source from the control system.

K. Torque Switch
1. Furnish torque switch at each end of travel.
2. Switch shall trip when the valve load exceeds the switch setting.
3. Switch adjustment device shall be calibrated directly in percent of torque.

L. Wiring: Wiring shall be terminated at a separately sealed terminal compartment.

M. Temperature Range: Actuator shall be capable of operating in an ambient temperature range of –20 to +160 deg F (with motor controls).

N. The required dynamic valve torque shall be no more than 60% of the electric actuator's maximum rated breakaway torque. Power gearing shall have zero backlash between the motor and actuator output.

O. All actuators shall be provided with the following:
1. Reversing starter.
2. Control transformer.
3. Phase rotation correction.
4. Monitor relay.
5. "Open – Close" pushbuttons.
6. "Local – Off – Remote" selector switch.
7. Red and green indicating lights or LED's.

P. Manufacturer: AUMA.

2.8 PNEUMATIC ACTUATORS

A. General
1. Pneumatically operated spring return actuators of the rack and pinion design, totally enclosed in a single enclosure with no external moving parts.
2. Actuators shall travel a minimum of 95 degrees in each direction to allow for over travel adjustment.
3. Output torque shall be linear throughout travel.
4. Factory lubricated with no field lubrication required.
5. Capable of mounting in any position without loss of performance.
6. Suitable for both on/off and throttling applications.
7. Heavy duty mechanical limit switches with solid state analog position feedback.
8. Visual position indicator.
9. Dual travel stops.
10. Manual over-ride on solenoids.
11. Adjustable open/close speed control.
12. Output torque: 44,130 lb-in minimum.

B. Materials of Construction:
1. Body and Endcaps:
   a. Extruded, anodized aluminum alloy.
2. Pistons:
   a. Die cast aluminum alloy.
3. Output Shaft/Pinion:
   a. 304 SST.
4. Travel stops:
   a. Alloy steel.
5. Shaft bearings and piston guides:
   a. Acetal.
6. Fasteners:
   a. 304 SST.
7. Spring:
   a. Spring steel with protective coating.
8. O-ring seals:
   a. Buna-N.
9. Temperature Rating:
   a. -4 to 200 degrees F.
10. Pressure Rating:
   a. Up to 140 psig.

C. Manufacturer: Bray Series 93 or Engineer Approved Equal.

2.9 ACCESSORIES

A. Flow Straighteners (Inlet Flow Conditioners)
1. Provide where indicated on process drawings.
2. Provide a certified drawing including dimensions, weight, welding requirements, material designations, material thicknesses and flange details for review with pump submittal.
3. Provide flow conditioning grid design approved by a nationally recognized physical hydraulic modeling laboratory.

a. For pipe sizes larger than 18-inch provide a design based on physical hydraulic modeling by a nationally recognized physical hydraulic modeling laboratory

4. Design Criteria:
   a. Spool, Minimum Length: 1 x Pipe diameter
      1) Ends: Flanged: ANSI 150-lb standard
      2) Type: Van Stone flat face rings and back-up flanges
   b. Grid, Minimum Length: 1 x Pipe diameter
      1) Thickness: 0.125 inch (3 mm)
      2) Grid Spacing: 4 inch (100 mm) nominal
      3) Velocity: Maximum 7 ft/s (2.13 m/s).
5. Materials:
   a. Spool: Type 316L A778 welded stainless steel pipe, Schedule 10S
   b. Van Stone flat face rings and back up flanges: Type 316Lstainless steel
   c. Hardware: Type 316 stainless steel
6. Finish:
   a. Pickled and passivated
   b. Completely immerse for a minimum of 15 minutes in 10 percent nitric acid and 3 percent hydrofluoric acid at 125 degrees Fahrenheit, followed by a neutralizing rinse.
7. Manufacturers:
   a. Flow Optimizers, LLC.
   b. Or Engineer approved equal.

B. Fire Hydrants
1. Cast Iron, conform to AWWA C-502, dry-barrel type.
2. Bell Connection Size: 6-inch.
3. Pumper Connection: One 4-1/2-inch diameter NST connection.
4. Main Valve Opening: 5-inch diameter Storz fitting and cap.
5. Hydrants shall have a 5-1/4-inch bronze to bronze seat.
6. Depth of Bury:
   a. Watermain 12-inches and less in diameter: 5’-0”
   b. Watermains greater than 12-inches in diameter: 5’-6”
7. Threads on nozzles shall match those standard for local fire department.
8. All valve shall open left.
9. Manufacturers:
   a. Mueller A-423 Super Centurion
   b. Kennedy 81A
   c. Darling B62B
   d. Clow Medallion

C. Pressure Gauges and Compound Gauges
1. Dial Size:
   a. 4-inch minimum.
2. Accuracy:
   a. Not less than 1/2 of 1% of scale range.
3. Connection:
   a. 1/2-inch NPT male connection
4. Dampening:
   a. Provide dampener (Ashcroft No. 1106 or equal) for each high service discharge gage.
5. Manufacturers:

a. Ashcroft/Duragauge.
b. AMETEK/Solfront 1929.
c. McDaniels/MPB/SC.

6. Materials of Construction:
   a. Case:
      1) Phenolic, PET turret, or fiber reinforced thermoplastic.
   b. Internals and wetted parts:
      1) 316 SST.
   c. Dampening fluid:
      1) Glycerin.
7. Mounting and installation:
   a. Provide SST piping and isolation valve. Refer to detail on Drawings.
8. Gage Schedule:
   a. As shown on Drawings.

D. Y-strainer
1. Description: Sediment strainer to protect pipeline comments by removing suspended solids and impurities.
2. Manufacturer/Model
   a. Asahi/sediment strainer.
   b. Engineer approved equal.
3. End Connection:
   a. True Union.
4. Pressure Rating:
   a. 150 psig (85 psi for valves larger than 3").
5. Screen Size:
   a. 20 mesh.
6. Materials of Construction:
   a. Body, screen support, end connection, union nut, retaining ring, and split ring:
      1) PVC with transparent body
   b. Filter screen:
      1) PVC.
   c. O-rings:
      1) EPDM (water service).
      2) PTFE (chemical service).
   d. Stop Ring:
      1) PVDF.

E. Quick Connect Coupling
1. Material: Polypropylene.
2. Ends: 150 lb. Flat face flange x female.
3. Provide polypropylene lockable cap.
4. Manufacturer: Banjo Corporation.

F. Valve Appurtenances
1. Valve Extension Stems, Stem Guides, Wrenches and Keys
   a. Extension Stem: Size at least as large as stem of operated valve.
   b. Intermediate Stem Guide(s): Install for extensions more than 8 feet long or as shown on the Drawings.
   c. Stem brackets and guides
      1) Cast iron having fully adjustable bronze bushed guide block.

2) Mounting: Comply with Division 40, Section “Pipe Supports”.
3) Stem brackets and guides located within the pre-treatment basins shall be 304 stainless steel as indicated on the drawings.

d. Operating nuts
1) Provide 2-inch square nut with each extension stem.
2) Locate in floor box or grating recess as required.

e. Number: Provide operating key or wrench of suitable length and size for each valve that is not readily accessible to direct operation.

G. Valve Floor Boxes
1. Location: Provide at all valves operated from floor above.
2. Construction
a. Material: Cast iron.
b. Depth: Metal floor slab thickness.
c. Cover: Cast iron with bronze bushing.

H. Expansion Joints
1. Expansion joint shall allow axial compression or expansion, lateral movement, and axial deflection.
2. Expansion joints shall be installed at the following locations:
a. Straight piping runs over 50 ft. and at least every 50 ft. for all interior PVC and CPVC chemical piping systems.
b. All locations as shown on the drawings.
3. Materials of Construction:
a. All Materials shall be NSF approved.
b. Elastomer:
1) EPDM.
c. Retaining rings:
1) 304 SST.
d. Control units, nuts, and washers:
1) 304 SST.
4. Install expansion joints in tension to facilitate removal.
5. Manufacturer/Model:
a. Proco/Style 231.
b. Engineer Approved Equal.

PART 3 - EXECUTION

3.1 VALVES, GATES AND ACCESSORIES: INSTALLATION

A. General
1. Install in accordance with Manufacturer's recommendations.
2. Install valves for convenient operation of hand-wheels or wrenches from the operating floor without interfering with access as acceptable to the Engineer or Owner.
3. Orientation of Valves
a. Install valves plumb and level unless otherwise approved.
b. Install valves free from distortion and strain caused by misaligned piping, equipment or other causes.

B. Fire Hydrants and Extensions
1. Fire Hydrants

a. Locate approximately as shown on the Drawings with final location and setting determined in field by Engineer.
b. Individually valve all new fire hydrant leads.
c. Use mechanical joint anchoring fittings as shown.
d. Install hydrants with suitable concrete backing and gravel fill for drainage as shown on Drawings.
e. Do not obstruct drain openings.

2. Hydrant Extensions
a. Provide complete, including barrel and stem sections, where shown on Drawings or directed by Engineer.
b. The Engineer or Owner reserves right to order extensions installed before or after hydrant setting.

C. Tapping Sleeves and Valves
1. Install where shown on the Drawings.
2. Install under pressure in strict accordance with Manufacturer's recommendations.
3. Satisfactorily test under 150 psi pressure prior to cutting operations. If leaks appear, make repairs and re-test.

D. Corporation Stops: Install at all points shown and where required to avoid air binding of piping systems.

E. Valve Appurtenances
1. Valve Boxes
a. Install plumb with the bodies centered directly over the valves.
b. Carefully tamp earth fill around each box to a distance of 4 feet on all sides.
c. Tamp earth fill to the undisturbed trench face, if less than 4 feet.

3.2 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping
1. Locations of existing piping shown shall be considered approximate.
2. Contractor is responsible for determining exact location of existing piping to which he must make connections, may disturb during earth moving operations, or may affect in any way by his work.

B. Removing Existing Pipelines from Service
1. Pipelines shall not be removed from service unless approved by the Engineer or Owner.
2. Notify the Engineer and Owner at least 48 hrs prior to taking pipeline out of service.

C. Work on Existing Pipelines
1. Cut piping as shown or required using machines designed specifically for this work.
2. Install temporary plugs to keep out all mud, dirt, water and debris.

END OF SECTION 40 0523

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SECTION 40 2319.01

PIPE SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles.

B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.

C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.

D. Pipe support locations and types for piping 1/2-inch (13 mm) and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports 1/2 inch (13 mm) and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.
   1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.

E. Design and provide all temporary pipe supports required during installation and testing.

1.2 REFERENCES:

A. The American Society of Mechanical Engineers (AMSE):
   1. B31.1: Power Piping.

B. ASTM International (ASTM):
   1. A36: Standard Specification for Carbon Structural Steel
   2. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
   3. A312: Seamless and Welded Austenic Stainless Steel Pipe
   4. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.
   5. A572: Specification for Steel Plate.
   6. E165: Practice for Liquid Penetrant Inspection Method.
   7. E709: Practice for Magnetic Particle Examination.

C. American Welding Society (AWS):
   1. D1.1: Structural Welding

D. Fluid Sealing Association: Technical Handbook.

E. Manufacturers' Standardization Society (MSS):
   1. SP-58: Pipe Hangers and Supports - Materials and Design.
   2. SP-69: Pipe Hangers and Supports - Selection and Application.
   3. SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.
   4. SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

1.3 SUBMITTALS:

A. Submit the following in accordance with Division 01, Section “Submittal Procedures”:
   1. Pipe support drawings specified herein and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.
      a. Detailed drawing of the device with dimensions.
      b. A table of applied forces and moments.
      c. A complete bill of materials.
      d. A unique identification and revision level.
      e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified herein.
      f. Detailed connections to existing structure.
      g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1.
   2. Welding Procedure: Submit description required to illustrate each welding procedure to be performed in the specified work.
   3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.
   4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.
   5. Pipe support manufacturers' qualifications as specified herein.
      a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.
      b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.
   6. Coordination drawings for pipe supports shall include as a minimum the following information.
      a. Coordination drawings shall include all pipe supports covered by specifications.
      b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal

including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.

c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.

d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4-inch (5 mm) scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-inches (50 mm) or less in diameter that will be field routed need not be shown on coordination drawings.

e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.

f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Engineer. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Engineer shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Engineer for resolution.

g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.

h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.

7. Written notification of any deviations from the requirements of this specification.
8. Support documentation and justification as specified.
9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.
10. Manufacturer's product data and specifications for shop painting.

B. Material Certification:

1. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. A copy of the contract mechanical process, and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
    a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
    b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.4 QUALITY ASSURANCE:

A. Provide in accordance with Division 01, Section “Quality Control”.

B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.

C. Welder Qualifications:
1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.

D. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

E. Structural Concrete: Conform to the requirements of Section 03 30 00. Concrete strength: 4,000 PSI (28 MPa) unless noted otherwise.

F. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

G. Pipe Support Manufacturer Qualifications:
1. Must possess a written quality assurance program.
2. Have a minimum of 5 years experience in the design and fabrication of pipe supports.
3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.
4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years experience in the design of piping systems and pipe supports.
5. Manufacturers' Standardization Society (MSS) Member.
6. Have a field service technician on staff with at least 5 years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.

H. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Division 01, Section "Product Requirements".

PART 2 - PRODUCTS

2.1 MATERIALS:

A. 316L Stainless Steel Supports: All submerged piping, piping within tanks/wet wells, and outdoor piping shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of 316L SST, unless otherwise indicated.

B. FRP Supports: All piping with chemical feed rooms and all piping carrying chemicals shall be supported with assemblies including framing, hardware, and anchors constructed of FRP, unless otherwise indicated. 316L SST supports are an acceptable alternate.

C. Hot Dipped Galvanized Steel Supports: Unless otherwise indicated, all other pipe support assemblies, including framing, hardware, and anchors, shall be of hot dipped galvanized steel construction.

D. Provide only new material. Previously used and/or scrap material is not acceptable.

E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.

F. Provide sliding Teflon plates. The sliding surfaces shall be a nominal 3/8-inches (10 mm) glass filled Teflon bonded to stainless steel backup plate with a 10 gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Conslide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc. or acceptable equivalent product.
   1. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:
   2. Tensile strength -2,000 psi (14 MPa).
   3. Elongation -225 percent
   4. Specific Gravity -2.17 to 2.22
   5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi (14 MPa).
   6. The compressive creep shall be a minimum of 2 percent at 2,000 psi (14 MPa) and 70 degrees F (21 degrees C).
   7. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer's plant.

G. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.

2.2 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS:

A. Design and provide pipe supports for piping 1/2-inch (13 mm) and larger to include the following loads:
   1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.
   2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.
   3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.
   4. Wind Loadings: Wind loadings.

B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.

C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.

D. Where possible, provide pipe supports, which are the manufacturers' standard products.
   1. Provide pipe supports with individual means of adjustment for alignment.
   2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.
   3. Hanger rods shall be subjected to tension only.
   4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.
   5. Provide concrete inserts capable of supporting the design loads.
   6. Metal framing systems will be acceptable to support piping 2 inch (50 mm) and smaller.
   7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16 gauge (1.5 mm) shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 inch (300 mm) in length.
   8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.
   9. Provide supplementary steel as needed.
   10. Do not support pipes from other pipe, conduits or metal stairs.
   11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.
   12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.
   13. All pipe supports located in fluid flow shall be supplied with double nutting.

E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.

F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

G. For piping 2-inch (50 mm) and smaller provide manufacturer's standard supports and standard spacing guidelines

H. Pipe supports connected to structural framing and slabs are subject to the following limitations:
   1. Less than 100 lb horizontal load per support.
   2. Vertical loads not to exceed an average of 100 P.S.F. for slabs, with a maximum vertical load per hanger of 2,500 lbs.
   3. Maximum of one pipe support per foot of slab width perpendicular to the span.
   4. Piping not supported from floors by metal framing must meet the limitations as specified above.

I. All outside above ground supports shall be Type 316L stainless steel as specified herein.

J. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.

K. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.3 FABRICATION:

A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.

B. Providing welding in accordance with Structural Welding Code.

C. Provide dimensional tolerances as specified in MSS-SP-89.

D. Provide threading and tapping in accordance with MSS-SP-89.

2.4 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Division 09, Section “High Performance Coatings.”

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.

B. Perform welding in accordance with Structural Welding Code:
   1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive

roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of grove welds for throat opening and for snug positioning for back-up bars.

2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.
3. Magnetic Particle Inspection: Perform in accordance with ASTM E709.
4. Liquid Penetrant Inspection: Perform in accordance with ASTM E165.
5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.
6. Test Locations: As selected by the Engineer.
7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.

C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Division 03, Section “Cast-in-Place Concrete.”

D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.

F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 inch/100 feet (10 mm/10 m), for each 100 degrees F (50 degrees C) change in temperature exceed 1/2-inch (13 mm), provide sliding supports.

I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8-inch (3 mm) thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.

J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.

K. Apply an anti-seize compound to nuts and bolts on all pipe supports.

L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.2 INSTALLATION OF BUILDING ATTACHMENTS:

A. Support piping from structural framing, unless otherwise indicated.

B. Concrete Inserts:
   1. Use existing embedded concrete items whenever possible.
   2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.3 THRUST ANCHORS AND GUIDES:

A. Thrust Anchors:
   1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.
   2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.4 PIPE SUPPORTS:

A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.

B. Provide minimum of two pipe supports for each pipe piece.

C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 inch (40 mm) out from face of wall and at least 3 inches (75 mm) below ceiling.

F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.

H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

J. Do not support piping from other piping.

K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

M. All rigid rod hangers shall provide a means of vertical adjustment after erection.

N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.

O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.

P. Hanger spacing shall not exceed the spacing listed below:
   1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.
   2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.

Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.

R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

S. All threads shall be UNC unless otherwise specified.

T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8-inch (3 mm) fillet weld, 1/2-inch (13 mm) long every 3 inches (75 mm) on center each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.

3.5 INSULATED PIPING:

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where vapor barriers are indicated on water piping, install coated protective shields.

END OF SECTION 40 2319.01

SECTION 40 4113

PROCESS PIPING HEAT TRACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:
   1. Self-regulating, parallel resistance.

B. Scope
   1. Heat tracing for all process piping, where identified on the drawings.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For electric heating cable.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Comply with IEEE 515.1.

B. Heating Element: Pair of parallel No. 16 AWG, tinned or nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

E. Maximum Operating Temperature (Power On): 150 deg F (65 deg C).

F. Maximum Exposure Temperature (Power Off): 185 deg F (85 deg C).

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Capacities and Characteristics:
   1. Maximum Heat Output: 5 W/ft. (16.4 W/m) or 8 W/ft. (26 W/m).
   2. Piping Diameter as indicated on process drawings.
   3. Number of Parallel Cables as required.
   4. Spiral Wrap Pitch as required.
   5. Electrical Characteristics for Single-Circuit Connection:
      a. Volts: 120.
      b. Phase: Single phase.
      c. Hertz: 60 Hz.
      d. Full-Load Amperes as required.
      e. Minimum Circuit Ampacity: 20A.
      f. Maximum Overcurrent Protection: 20A.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:
   1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F (minus 1 to plus 10 deg C).
   2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
   3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
   4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 26 0553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
   1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
   2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

2.4 MANUFACTURERS

A. Following are the manufacturers:
   1. Raychem
   2. Or approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:
   1. Install electric heating cables after piping has been tested and before insulation is installed.
   2. Install electric heating cables according to IEEE 515.1.
   3. Install insulation over piping with electric cables according to process pipe insulation.
   4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

D. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   2. Test cables for electrical continuity and insulation integrity before energizing.
   3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables shall be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Remove and replace damaged heat-tracing cables.

END OF SECTION 40 4113

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SECTION 40 9000

PLANT INSTRUMENTATION AND
CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, and place in satisfactory operation, instrumentation and control system equipment necessary to perform specified functions in accordance with the requirements of Sections 40 9XXX and the Drawings. The system includes, but is not necessarily limited to, the following equipment:
   1. Primary sensor/transducers, field instruments, and associated mounting hardware as specified in Section 40 9100, Primary Sensors and Field Instruments.
   2. Local control panels, monitoring panels, and existing panel modifications as shown on the Drawings.
   3. An expansion of the existing plant-wide control system including processors, communication modules, input/output modules, operator interface stations, as specified and as shown on the Drawings.
   4. Interconnecting cables, wiring, and associated components. Ethernet networking components such as switches, transceivers, fiber optic and twisted-pair patch panels and patch cables, and equipment enclosures as specified and shown in the Contract Documents and in Section 40 9553, Network Devices.

B. Configuration and programming of control system end devices such as but not limited to: instruments, device serial networks, actuator master stations, variable frequency drives, motor protection units, actuators, etc., shall be provided by the Contractor. Unit process logic residing in the process area PLC(s), OIT system and/or HMI system depicting the process monitoring and controls shall be provided by the Contractor.

C. This Section and the other Division 40 Sections illustrate and describe the overall instrumentation and control system functional and operational requirements.

D. Contractor shall conform to the requirements specified within Division 40 9000 for the selection of equipment and materials, installation methods, configuration and programming. In addition, it should be noted that Division 40 9000, Plant Instrumentation and Control System General Requirements, are not limited to work in this Division, but are also imposed for equipment and systems specified in other Divisions of the Contract Documents.

E. Related Sections:
   1. Section 40 9100, Primary Sensors and Field Instruments
   2. Section 40 9443, Plant Control System
   3. Section 40 9513, Control Panels
   4. Section 40 9553, Network Devices

1.2 REFERENCES

A. Reference Standards: The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in this Specification and the Drawings.
   1. American National Standards Institute (ANSI)
   2. ANSI C1, "National Electrical Code" (NEC)
   3. Factory Mutual (FM)
   4. Institute of Electrical and Electronic Engineers (IEEE)
   5. Instrumentation, Systems, and Automation Society (ISA)
   6. Society of Automotive Engineers (SAE)
   7. National Electrical Manufacturers Association (NEMA)
   8. National Fire Protection Association (NFPA)
   9. National Institute of Standards and Technology (NIST)
   10. Scientific Apparatus Makers Association (SAMA)
   11. Underwriters Laboratories (UL)
   12. Occupational Safety and Health Administration (OSHA)

1.3 DEFINITIONS

A. Control System: The Control System shall be comprised of all the instrumentation and control system equipment throughout the Contract Documents, including but not limited to:
   1. Instrument loop components including, but not limited to: primary elements, sensors, transducers, transmitters, indicators, controllers, and recorders.
   2. Final operators or control elements including, but not limited to: control valves, solenoids, motors, adjustable frequency drives, and louver operators.
   3. Indicating and control devices including, but not limited to: operator interface terminals, pushbuttons, selector switches, pilot lights, recorders, and indicators.
   4. Ancillary components including, but not limited to: instrument power supplies, signal repeaters, signal isolators, current trips, adder/subtractor modules, relays, and timers.
   5. Instrumentation power requirements including, but not limited to: dedicated power, power conditioning, uninterruptable power supplies, and grounding systems.
   6. Cabinets, consoles, panels, and enclosures
   7. Alarm systems
   8. Boiler controls and control systems
   9. Controls for process equipment and systems including, but not limited to: service pumps, chemical systems, filtration, sample pumps, sump pumps, and treatment systems
   10. Motor controls
   11. Programmable controllers (PLCs)
   12. Distributed control systems (DCSs)
   13. Supervisory control and data acquisition systems (SCADA)
   14. Wiring and conduit
   15. Network Communication system equipment and wiring

B. Instrumentation and Control System Integrator: The instrumentation and control system integrator shall furnish a complete and integrated instrument and control system including, but not limited to: detailed design, engineering, fabrication, assembly, testing, checkout, commissioning, debugging, and training in accordance with the Contract Documents.

1.4 SYSTEM DESCRIPTION

A. General Design Requirements:

1. Power Supplies:
    a. All electrically powered equipment and devices shall be suitable for operation on 115 V +/- 10%, 60 Hz +/- 2 Hz power. If a different voltage or better regulation is required, a suitable regulator or transformer shall be provided.
    b. Appropriate 24 VDC power supplies for analog loop power shall be furnished for each two wire transmitter. Power supplies shall be mounted in control panels or enclosures.
    c. Provide power supplies sized for a minimum of 130% of the maximum simultaneous current draw of all connected load.
    d. A power on off switch or a molded case circuit breaker shall be furnished for each item requiring 120 VAC electrical power.
    e. Provide isolation transformers, transient voltage surge suppressers, line voltage regulators, and output line reactors for power distribution as required to eliminate electrical noise and/or transients entering on power lines.
2. Signal Requirements:
    a. The control system shall be designed to use 4 to 20 mA DC analog signals and/or digital communication networks as specified in Sections 40 9XXX, or as shown on Contract Drawings.
    b. Signal converters and repeaters shall be provided where required for proper interfacing. Power supplies shall be sized adequately for signal converter and repeater loads.
    c. Signals shall be isolated from ground. Shields of 4 to 20 mA and thermocouple 2-wire systems shall be grounded at a single point only. Ground 4 to 20 mA shields only at the control panel that contains the associated 2-wire loop power supply, unless shown otherwise. Ground thermocouple sensors at the thermocouple.
    d. This system will be used in a water treatment plant environment where there can be high energy AC fields, DC control pulses, and varying ground potentials between the sensors/transducers and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.
3. Miscellaneous:
    a. All new equipment provided shall be listed by Underwriters Laboratory or other testing agency as defined in these Specifications. Such listing requirements only apply for equipment where such listings exist.
    b. All instrumentation and control system components shall be heavy duty types, suitable for continuous service in a municipal water treatment plant environment.
    c. All similar components shall be products of a single manufacturer and shall consist of equipment which are currently in production and shall remain in production for at least 2 years.
    d. All instrumentation and control system components shall be designed to automatically return to accurate measurement within 60 seconds upon restoration of power after a power failure or when transferred to standby power supply.
    e. Surge and lightning protection shall be provided for all power supplies, field instruments, and all other control system components to protect against damage by electrical surges.
    f. All field mounted instruments and system components shall be designed for installation in high humidity and corrosive service conditions. All field mounted instrument enclosures, junction boxes, and appurtenances shall have a NEMA 4X endorsement, at a minimum. Hazardous areas require a NEMA 7 endorsement.

g. All components with interconnections to field devices shall be wired through terminal blocks. Integral terminals, such as that of a relay, are not an acceptable alternate.
h. All components furnished including field and rear of panel instruments shall be tagged with the item number and nomenclature indicated on the Contract Documents and/or approved Shop Drawings.
i. Ranges and scales specified herein shall be coordinated to suit field conditions and equipment furnished.
j. Field mounted devices, instruments and control panels/enclosures located outdoors shall be protected from exposure to freezing temperatures and from overheating due to prolonged exposure to high ambient temperatures and shall be provided with sunshields where necessary to protect the enclosure surfaces from the additional heating effects of exposure to direct sunlight.
k. Field instruments mounted in hazardous areas shall be provided as "factory sealed" units whenever available which can be installed in non-explosion proof enclosures in Division 2 areas and in explosion proof enclosures in Division 1 areas, in both cases without the need for conduit seals.

4. System Designs:
a. Range, scale, and setpoint values specified are for initial setting and configuration. Modifications to these values may be required based on actual equipment furnished and as necessary to implement proper and stable process actions which are determined as systems are placed in operation. These modifications shall be done by Contractor at no additional cost to the Owner.
b. For any items where ranges, scales, and setpoints may not have been specified, Contractor shall submit a recommendation to the Owner for review.

1.5 SUBMITTALS

A. Product Data: Control System Components Submittal Requirements:
1. Sensors/transducers and field instruments: Product data and Manufacturer's literature include the following:
a. Instrument Specification Form: SP20 Instrumentation Specification Forms were developed by the ISA Standards Committee for most commonly used instruments. Submit a completed SP20 instrument specification form for each instrument.
b. Manufacturer's product name and model number and all required accessories
c. Instrument tag number from Contract Documents
d. Manufacturer's standard catalog product data with irrelevant sections crossed out.
e. Description of construction features
f. Performance and operation data
g. Installation and mounting details, instructions, and recommendations
h. Identification of all wiring interconnections and points of connection
i. Service requirements
j. Dimensions
2. Programmable Controller (PLC) System Information:
a. System Description:
1) Detailed block diagram showing system hardware configuration and identifying manufacturers and model numbers of system components.
2) Format, protocol, and procedures for remote communications and local communications with input/output modules and peripheral devices
3) On-line and off-line capabilities for programming, system utilities and diagnostics

4) Input/output point listing with I/O module cross reference identification
5) List of repair parts and test equipment

b. Equipment Hardware:
1) Manufacturer's standard catalog product data for all system components
2) Layout drawings showing front, rear, end, and plan views to scale of all processing equipment, I/O components, power supplies, and peripheral devices.
3) Construction details, features, and procedures
4) Interconnection diagrams including termination details, cable identification lists, and cable lengths
5) Plans showing equipment layout in control panels
6) Installation requirements, instructions, and/or recommendations

c. Software Description:
1) Standard technical documentation covering all aspects of the programmable controller software functions and capabilities, including functional descriptions and programming procedures related to control, monitoring, logging, and alarming functions.
2) Documentation describing memory type, size and structure, and listing I/O and Data Table memory and size of memory available for programs.

3. Control Panel and Enclosure Information:
a. Layout Drawings shall include the following:
1) Front and plan views to scale
2) Dimensional information
3) Tag number and functional name of components mounted in and on panel or enclosure
4) Product information on all panel components:
a) Manufacturer's product name and model number
b) Instrument tag number from Contract Documents
c) Manufacturer's standard catalog product data with irrelevant information crossed out
d) Description of construction features
e) Performance and operation data
f) Installation and mounting details, instructions, and recommendations
g) Identification of all wiring interconnections and points of connection
h) Service requirements
i) Dimensions
5) Nameplate location and legend including text, letter size, and colors to be used
6) Location of anchoring connections and holes
7) Location of external wiring and/or piping connections
8) Mounting and installation details

b. Panel schematic and internal point-to-point wiring and/or piping diagrams shall include the following:
1) Name of panel or enclosure
2) Wiring sizes, types, and numbers
3) Piping sizes, types, and numbers
4) Terminal strip and block numbers for all interconnections.
5) Color coding
6) Functional name and manufacturer's designation for components to which wiring and piping are connected

c. Electrical control schematics in accordance with SAE HS-1738 standards for all circuits indicated in the specifications or on the Contract Drawings. Generic or typical wiring diagrams, not specific to equipment being provided, will not be accepted. Tables or charts to describe wire numbers will not be accepted. All wires shall be labeled and shown on the submittal drawings as shown on the sample drawings at the end of this Section.

d. Plan showing control panel and enclosure equipment layout in each area.

e. Stock lists or Bill of Materials for each panel including tag number, functional name, manufacturer's name, manufacturer's model number, and quantity for all components mounted in or on the panel or enclosure. Bill of Materials shall include the information shown on the sample drawings at the end of this Section.

f. Heat calculations for each panel or enclosure to verify that there is sufficient dissipation and/or generation of heat to maintain interior panel temperatures within the maximum and minimum operating temperature of all panel components with ambient temperatures as specified below.

g. Samples:
   1) One (1) sample nameplate for exterior panel mounting
   2) One (1) sample nameplate for interior panel device mounting
   3) One (1) sample terminal block
   4) Three (3) sample wire labels

4. Field Wiring (Riser) Diagrams:
   a. Shall include the following:
      1) Wiring and conduit sizes, types, and numbers
      2) Terminal strip numbers for each wire termination
      3) Color coding
      4) Location, functional name, and manufacturer's designation of items to which wiring and/or piping are connected
      5) Point to point wiring diagrams shall include all interconnections between field devices, panels, control stations, lighting panels, and motor starters.

5. PLC I/O Loop Wiring Diagrams:
   a. Prepare drawings on a module-by-module basis and include the following information:
      1) Rack numbers, module type and slot number, and module terminal point numbers. Also include location and identification of all intermediate panel and/or field terminal block and strip numbers to which I/O wiring and power supply wiring is connected. Identify all power supply circuit numbers and ratings.
      2) Wiring sizes, type, wire numbers and color coding
      3) Designation of conduits in which field I/O wiring is routed
      4) Location, functional name, tag numbers and manufacturer model numbers of panel and field devices and instruments to which I/O wiring is connected. For discrete I/O devices use P&ID electrical symbols tagged with designation shown on SAE HS-1738 drawings.

B. Operation and Maintenance (O&M) Manuals:
   1. Operating and Maintenance Instructions, the Instrumentation and Control System O&M Manuals shall include:
      a. Name, address, and telephone number of each manufacturer's local service representative. Also include internet web site URL and email address when available.

b. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.
c. Copy of all approved submittal information and system shop drawings as specified herein with corrections made to reflect all shop drawing review comments and the actual system as tested and delivered to the site for installation.
d. Manufacturer's Original Copies of Hardware, Installation, Assembly, Programming, and Operations Manuals for all control system components. Manuals shall include the following information:
    1) General descriptive information covering the basic features of the equipment
    2) Physical description covering layout and installation requirements and all environmental constraints
    3) Standard technical documentation covering the procedures for programming, operation, start-up, shutdown, and calibration of the equipment and explaining how the various control functions are performed.
    4) Principles of operation explaining the logic of operation; provide information covering operation to a component level.
    5) Maintenance procedures covering checkout, troubleshooting, and servicing; checkout procedures shall provide the means to verify the satisfactory operation of equipment, trouble-shooting procedures shall serve as a guide in determining faulty components, and servicing procedures shall cover requirements and recommended time schedule for calibration, cleaning, lubrication and other housekeeping and preventive maintenance procedures.
    6) Wiring, schematic, and logic diagrams
    7) Safety considerations relating to operation and maintenance procedures
    8) Manufacturer's recommended spare parts list with model numbers

2. After the initial Operating and Maintenance Instructions have received an acceptable disposition, the manual has been field verified and all final corrections have been made by the Contractor, submit 2 electronic versions of the approved manuals on CD to the Owner.
    a. The electronic color copy shall be an original, computer generated multi-page Portable Document Format (PDF) file. Scans or pictures of document text will not be accepted.
        1) Provide a hyperlinked and bookmarked colored index page hyperlinked and bookmarked to appropriate pages. There shall be a universal return to the index on all pages linking back to the index page.
        2) All oversized pages shall be properly sized (to original dimensions) and orientated correctly.
        3) Each PDF file shall be no larger than 100 Mb. Any additional files shall be suffixed with an underscore and a number indicating its position.
    b. Data files, such as those for drawings, source code, ladder logic, etc. shall be submitted in its native electronic format, in addition to PDF form for printing.
    c. If self-adhesive labels are provided, it must fully cover the CD and be exactly centered on the CD. The front surface of the CD shall contain the following type written information:
        1) Contract number
        2) Specification Section number
        3) Submittal number
        4) Brief submittal description
        5) Submittal date

C. Supplier's Qualifications:

1. Shall submit experience of successful instrumentation and control system equipment installations as specified in paragraph 1.6 of this Section.

D. Installation/Inspection Data:
   1. Prior to commissioning, furnish to Owner an installation inspection report certifying that all equipment has been installed correctly and is operating properly.
   2. The report shall describe the inspection and test procedure and include any repairs, modifications, or other work performed during the factory test or on-site.
   3. The report shall be signed by the Contractor and the system integrator's authorized representative.

E. Product/Material Certifications
   1. Submit to the Owner certified calibration certificates for field instruments and devices specified in Section 40 9XXX, a minimum of 3 weeks prior to commissioning.
      a. Receipt of any calibration certificate shall in no way imply acceptance of any work or instrument.
      b. The calibration certificates shall contain the information shown on the sample calibration certificate included at the end of this Section.
      c. Each calibration certificate shall be signed and dated by the authorized manufacturer's representative and Contractor.

F. Record Drawings and Documentation:
   1. All revised shop drawings and documentation shall be submitted to the Engineer to replace out dated drawings and documentation contained in the System O&M Manuals. Specific instructions for out dated drawing removal and replacement shall be provided with the record drawing submittal.
   2. Record Drawings shall include all data required to identify, locate, and trace circuits.
      a. Required data shall include, but not be limited to, equipment names, conduit numbers, boxes, conductor labels and colors, and terminals.
      b. Control Panel Layout Drawings shall include, but not be limited to, the following information:
         1) Bill of materials identifying all components
         2) Enclosure layouts (interior and exterior) including face, sides, back, and subpanels identifying all components
         3) Nameplate legend for all components
      c. Interconnect Wiring Diagrams shall include, but not be limited to, the following information:
         1) Identify all wiring components between each end device and PLC terminal(s).
         2) Conductor labels shall be consistent throughout loops.
      d. Control Diagrams shall include, but not be limited to, the following information:
         1) Index of equally spaced reference numbers along left side of Control Diagram
         2) Include terminal numbers/colors for each control component.
      e. Provide separate connection drawings for components requiring greater number of interconnects to maintain clarity of information.
         1) Information shall include terminal numbers, conductor labels, point, polarity, and function.
      f. Terminal strip drawings shall include terminal strip name, number, point, and conductor label on each side of terminal.

g. PLC rack layout drawings shall include physical module/slot configuration along with point number and description.

3. All Electrical and Instrumentation Record Drawings shall be submitted in hard copy format.

G. Commissioning Procedures and Documentation:

1. Provide the following approved and updated documentation for use before system commissioning.
   a. Complete panel schematic and detailed internal point-to-point wiring interconnect drawings
   b. Complete electrical control schematics
   c. Complete panel layout drawings
   d. Complete field wiring diagrams
   e. The drawings corrected and modified by the Contractor during commissioning shall form the basis for the "As-Built" record drawing requirement as specified in this Section.

H. Storage Requirements:

1. System Integrator shall submit to Owner the storage requirements and recommendations for the equipment prior to shipment.

1.6 QUALITY ASSURANCE

A. General:

1. The instrumentation and control system shall be furnished by a single supplier who shall assume responsibility for providing a complete and integrated system.
2. All equipment, components, and materials required shall be furnished by the single supplier who shall assume the responsibility for adequacy and performance of all items.
3. The supplier shall identify those system components which are not of his manufacture.
4. The supplier shall supply his company's quality assurance plan, and for components which are not of his manufacture, the component manufacturer's quality assurance plan. The plans shall include but not necessarily be limited to: method of testing, raw material criteria, methods of documentation, station control, "Burn In", final tests, serialization coding, and packaging.

B. Instrumentation and Control System Integrator's Qualifications:

1. Shall be a financially sound firm having at least 5 years continuous experience in designing, implementing, supplying and supporting instrumentation and control systems which are comparable to the instrumentation system in terms of hardware, software, cost, and complexity.
2. Shall have in existence at the time of bid advertisement, an experienced engineering and technical staff capable of designing, implementing, supplying, and supporting the instrumentation system and handling the submittal, testing, and training requirements.
3. Shall have an emergency response time ability of less than 4 hours to the project site.
4. Shall have a thorough working knowledge of water/wastewater treatment processes and control philosophy in accordance with standard practices of the water/wastewater treatment industry.
5. System Integrator shall be one of the following:
   a. Dublin Technical Systems, Inc. of Dublin, Ohio
   b. Dmytryka Jacobs Engineers, Inc. of Toledo, Ohio
   c. Quality Controls, Inc of Cincinnati, Ohio

C. Instrumentation and Control System Integrator's Responsibility:
   1. Contractor shall retain the system integrator to assume the responsibilities specified below. However, execution of these specified duties by the system integrator shall not relieve Contractor of the ultimate responsibility for the control equipment.
      a. Detailed design, engineering, fabrication, assembly, wiring, testing, and debugging of the instrumentation and control system in accordance with the Contract Documents, the reviewed submittal drawings, and all referenced standards and codes.
      b. Preparation, assembly, submission, and correction of all instrumentation and control system submittals in accordance with the Contract Documents.
      c. Proper integration and interfacing of the instrumentation and control system hardware, field devices, and panels including required interfacing with package control systems furnished by other equipment suppliers, with existing equipment, and with the plant electrical system.
      d. Supervision of the installation of the instrumentation and control system, instruments, panels, cabinets, wiring, and other components require.
      e. Calibration, testing, and startup of the instrumentation and control system.
      f. Training of Owner personnel in operation and maintenance of the instrumentation and control system.
      g. Handling of all warranty obligations for the control system components.

D. Coordination and Progress Meetings:
   1. Contractor and a representative of the system integrator shall be required to attend meetings applicable to this Section's scope of work.
   2. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit the Contractor and system integrator to agreed procedures and schedules.

E. System Integrator Project Personnel:
   1. Contractor shall require the system integrator to provide the following project personnel:
      a. Project Manager:
         1) The system integrator shall appoint a project manager who shall coordinate and schedule all work and assure that the project schedule is met.
         2) The project manager shall act as the liaison with Contractor for the installation of the instrumentation and control system equipment and shall assist in all matters required for proper coordination and interfacing of the equipment and processes.
      b. Field Engineer:
         1) The system integrator shall appoint a field engineer with responsibilities as follows:
            a) Provide advice and technical consultation relative to installation techniques and procedures for equipment furnished.
            b) Provide guidance and support on-site throughout the control system installation and start-up period.
            c) Installed system checkout, calibration, adjustment, and start up including tuning of every control loop.
            d) Involvement in the onsite system training of plant personnel.
            e) Resolving of control problems encountered during initial startup and testing of all instrumentation and control equipment.

2) The field engineer shall have a minimum of 5 years experience in systems engineering and start up and shall have a thorough working knowledge of the hardware supplied for the instrumentation and control system.

c. The system integrator shall submit resumes for Field Engineer which detail their relevant experience as specified above.

1.7 DELIVERY, STORAGE AND HANDLING

A. Instrumentation and control system equipment shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage.

B. All equipment shall be handled and stored in accordance with manufacturer's instructions and relevant organization standards. Owner shall have the right to inspect stored equipment.

C. Packing and Shipping
1. Package equipment as required to protect it from damage.
2. Mount heavy items on pallets or skids to facilitate handling.

D. Acceptance at Site
1. Inspect all equipment at the time of delivery.
   a. Ensure that no damage has occurred during shipment.
   b. Verify make, model, and quantity.
2. Record the following information:
   a. Description/model of equipment.
   b. Date and time of delivery.
   c. Assessment of condition.
3. Handle equipment carefully to prevent damage.
4. Remove any damaged equipment from site and replace with new equipment.

E. Storage and Protection.
1. Store the equipment provided until it can be installed.
2. Provide a clean, dry, heated, and dust-free location for storage.
3. Such conditions must meet the requirements of the system integrator and manufacturer.

1.8 PROJECT/SITE CONDITIONS

A. Interior Locations: The following are defined as interior locations:
1. Any location within the boundaries of the foundation of any building.
2. Any location within the superstructure of other structures not classified as buildings.

B. Wet Locations: The following are defined as wet locations:
1. All exterior locations.
2. All interior locations below grade.
3. All interior locations where wet materials are processed, pumped, transported, or stored.

C. Corrosive Locations: The following are defined as corrosive locations.
1. All locations with chemical feed/transfer equipment
2. All locations with chemical storage tanks
3. All locations where chemical storage drums are located.

D. Environmental Conditions:
   1. The control system shall be designed and constructed for continuous operation without forming condensation under the following temperature and humidity conditions:
      a. Space Conditioned Areas shown on the Drawings:
         1) Ambient Temperature: normal conditions 59 to 90°F; abnormal conditions 40 to 104°F.
         2) Relative Humidity: normal conditions 20 to 80%
         3) Abnormal conditions up to 95%
      b. Indoor locations for control panels and instruments:
         1) Ambient Temperature: 40 to 120°F
         2) Relative Humidity: 0 to 100%
      c. Outdoor locations for instruments:
         1) Ambient Temperature: -30 to 120°F
         2) Relative Humidity: 0 to 100%

E. Wet and Corrosive Areas:
   1. Instruments and control system components shall be designed and constructed to provide adequate protection against corrosion from gases and chemical which are commonly found in water/wastewater treatment plant environments such as but not limited to zinc orthophosphate, ozone, oxygen, chlorine, and carbon dioxide.

F. Portions of the instrumentation and control system will be located in areas that may be subjected to excessive vibrations. The control system integrator/manufacturer shall specify any vibration limitations which are required for the equipment and provide vibration proof mountings accordingly.

G. Hazardous (Classified) Areas: Hazardous (classified) areas are defined as in accordance with the NEC, NFPA 820, and as shown on the Drawings. All equipment installed in these areas shall conform to requirements for installation in the designated hazardous area as described in Articles 500, 501, and 502 of the NEC.

PART 2 - PRODUCTS

2.1 GENERAL

A. Mounting Hardware: Provide mounting hardware meeting the requirements of Division 26.

B. Identification: Provide equipment identification meeting the requirements of Division 26.

C. Calibrators and Programmers
   1. Provide calibrators/programmers for all I&C equipment that cannot be calibrated from the controls built into the unit.
   2. Provide a minimum of one calibrator/programmer for each type of equipment supplied.

D. Adjustable Dead-Band
   1. Provide dead-band adjustment for all output contacts from all I&C equipment.
   2. Provide a minimum of ±10 percent adjustment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions
   1. Compare the site and existing facilities with the Contract Documents.
   2. With respect to the conditions of the premises, locate connections of existing facilities and any obstructions that may be encountered and conduct work to minimize disruption to existing conditions.

B. Field Measurements: Field-verify all locations and dimensions to ensure that the equipment will be properly located, readily accessible, and installed in accordance with all pertinent codes and regulations, the contract documents, and the referenced standards.

3.2 INSTALLATION - GENERAL

A. General
   1. Equipment locations as shown on the drawings are approximate unless dimensioned.
   2. Coordinate equipment locations with existing conditions and adjust locations as required.
   3. The Contractor shall furnish, fabricate, and mount all instrument stands and brackets. Mounting of stands and instruments shall be per installation detail drawings. All stands must be level, plumb, rigid, and free from vibration. Additional support shall be added where required for vibration-free mounting.
   4. Once instrumentation and control equipment has been set in place, Contractor shall maintain Space Conditioned Areas dust-free and with the following environmental conditions:
      a. Ambient Temperature: 65 to 80°F
      b. Relative Humidity: 50 to 70%
      c. Chlorine: ISA S71.04, Class G2 or better
   5. Provide temporary heating, cooling, dehumidification, humidification and air purification as necessary to provide the above conditions

B. Instrumentation wiring is shown schematically on the plan or described by narrative in the specifications. Contractor to provide type and quantity of wiring necessary to perform the function specified in Sections 40 9XXX and shown on the Drawings. See Division 26 wire and cable sections for "uses permitted." Analog signal conductors and discrete signal conductors shall always be in separate conduits or cable tray compartments. Power wiring shall be in conduits and cable tray compartments separate from all signal wiring.
   1. The Contractor shall terminate field wiring for equipment specified under this section. The system integrator shall check instrument installation and field wiring before instrument devices are electrically powered by Contractor. Wires shall be terminated at terminal blocks with crimp type, preinsulated tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. All signal shields shall have only one ground point that shall be located at the closest control panel. Seal around all conductors inside conduits as they enter equipment. Use watertight seal (closed cell RTU foam type) entering or leaving every building, box, or instrument. Install conduit water relief or "weep" on the system side of all seals to prevent intrusion of water into the equipment.
   2. Spare Wiring: Signal and interlock wiring shall contain spare conductors in every raceway. Spare conductors shall be provided in pairs and shall be clearly and distinctly marked at every access point indicated where the pairs start and stop. The minimum number of spare pairs shall be 25 percent of the number of active pairs with a minimum of one spare pair.

C. Valves

1. General Application: Use gate and ball valves for shutoff duty; globe and ball valves for throttling duty.
2. Access: Locate valves for easy access and provide separate support where necessary.
3. Unions: Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown.
4. Stems: Install valves in horizontal piping with stem at or above the center of the pipe.
5. Clearance: Install valves in a position to allow full stem movement.

D. Threaded Connections
1. Procedure
   a. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
   b. Align threads at point of assembly.
   c. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
   d. Assemble joint, wrench-tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

E. Tagging
1. All instrumentation equipment shall be provided with identification tags in accordance with the plans and Division 26 Section “Electrical identification”. Each field instrument shall have a stainless steel tag.
2. The device tags shall be mounted using stainless steel screws.

3.3 ADJUSTING

A. Set Points: Alarm and control set points shall be adjusted to their operational values before the start of the field test.

B. Calibration: Calibration adjustments shall be performed before the start of the field test. Testing shall commence after calibration verification for each instrument is provided to the Engineer.

3.4 FIELD QUALITY CONTROL

A. Piping Tests: After piping systems have been put into service, inspect for leaks. Adjust pipes, valves, or fittings to stop leaks; replace equipment if leak persists.

B. Field Test
1. A technical representative of the system integrator and the Contractor shall perform a field test on the entire instrumentation and control system. All equipment provided by the system integrator and all interrelated equipment provided by other suppliers, such as pumps, blowers, valve operators, chemical feeders, motor controls, etc., shall be installed and operating properly before the test starts.
2. All test equipment and materials shall be provided by the system integrator.
3. As a minimum, the test shall consist of the following:
   a. All wiring shall be checked at each termination point for correct wire size, type, color, termination, and wire number.
   b. All instruments and devices shall be checked to verify compliance with the specifications and approved shop drawings. The calibration of analog devices shall be verified including the zero and span.

c. Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.
d. All digital inputs shall be activated at the field element to verify proper response on the OIT.
e. All analog inputs shall be tested at the field transmitter over a full range to verify proper response at OIT. Analog loops shall be verified at each termination point at 0, 25, 50, 75 and 100% signal levels.
f. All digital and analog outputs shall be forced, via the OIT, or PLC if necessary, to verify proper response at the final control element.
g. Communications shall be tested between all components, including existing equipment.
h. Verify proper calibration of all instruments by independent measurements, such as checking levels with a measuring rod or pole, performing drawdown tests on wells to check flow rates, performing laboratory tests on samples, etc.
i. Create temporary test conditions to simulate variations in process operation by throttling valves, controlling pump speed, shutting down process equipment, operating safety devices, etc. Where safety concerns or process limitations prohibit physical simulation and when agreed to by the Owner, simulated process signals may be used. Test conditions shall be sufficient to test the operation of every function of the instrumentation and control system including:
    1) Alarms and safety shutdowns.
    2) Equipment start/stop and speed controls.
    3) Pacing of chemical feed equipment.
    4) Recorders and indicators.
    5) Process controller operation and recovery from upsets.
    6) Programmable logic controller (PLC) or Supervisory Control and Data Acquisition (SCADA) system inputs and outputs.
    7) PLC or SCADA system programming.
j. The test shall be performed according to the test procedures submitted. As each phase of the test is completed, test data sheets shall be signed and dated. The test data sheets shall document any modifications to the control and alarm settings, process engineering unit changes, programming changes, wiring changes, problems encountered, and steps taken to solve the problems.
k. The commissioning effort shall be documented using forms similar to the sample Loop Validation/Inspection Tests form at the end of this Section.

3.5 CLEANING

A. Instrumentation System: The instrumentation system components shall be kept clean and free of dust during the storage, start-up, demonstration, and warranty period.

B. Control Panels and Consoles: Clean dust and dirt accumulation inside and outside control panels and consoles, on a monthly basis, during start-up and demonstration period.

3.6 DEMONSTRATION

A. General: The Contractor shall perform a 30-day operational demonstration of the complete instrumentation and control system. The demonstration shall conform to the following requirements. The 30-day operational demonstration shall not begin until the field test is completed and all problems and defects encountered during the field test have been corrected.

B. System Acceptance: System acceptance shall not occur until the entire instrumentation and control system has performed as a functioning unit continuously for 30 consecutive days without loss of control and monitoring function, except for periods of scheduled maintenance. Failure of any component, software function, or required function shall require a restart of the 30-day operational demonstration until 30 consecutive days of continuous operation have been completed.

C. Staffing: Provide for the services of a qualified service technician for the duration of the 30-day demonstration. The service technician shall be on call 24 hours per day, 7 days a week.

3.7 PROTECTION

A. The Contractor shall protect the instrumentation system components from water, dust, dirt, and corrosion during the start-up, demonstration, and warranty period.

3.8 INSTRUCTION OF PERSONNEL

A. Field Training: Training shall be conducted on all I&C equipment provided under the 40 9XXX series Sections, and related electrical and interfaces to equipment provided by other division sections. Training sessions shall be conducted as follows:
   1. Provide 40 hours of training by factory-authorized representative of equipment to Owner's personnel.
   2. Training courses shall include hardware components emphasizing operation, calibration, maintenance, interface with other systems, and associated theory.
   3. Minimum Goals: Training shall incorporate operational requirements described in these specifications. Training shall provide the plant operations personnel with the following:
      a. Control set point and dead band modifications.
      b. Control system start-up and shutdown.
      c. Routine diagnostic checks and maintenance.
      d. Field instrument calibration and maintenance.
      e. Equipment diagnostic testing and replacement of failed parts.
   4. The process control system integrator shall submit a training program that provides the plant operations personnel a theoretical background and a broad range of related skills to achieve the listed goals. The instructor(s) shall be experienced in system applications similar to the equipment specified herein. The resumes of the training staff for instructing the plant operations personnel shall be available for review by the Owner. The plant operations personnel trainees shall be subjected to program testing, evaluation, and counseling. Study assignments shall be made and later reviewed by the instructors to the satisfaction of class attendees. Trainees shall be encouraged to freely ask questions during the instruction periods.
   5. The Contractor shall provide all classroom training courses and all hands-on training at the project site. Contractor shall provide tables, chairs, and all training documentation for training attendees.
   6. Provide text material for self-study and to supplement classroom lectures. The personnel attending the training courses shall be permitted to retain text materials for future reference.

B. The Contractor shall develop a training program tailored to the Owner's needs including type and quantity of treatment plant personnel, a curriculum of described courses, duration of courses, and training facilities. The Contractor shall submit for approval a detailed outline of the proposed training schedule, how the training courses are to be conducted, and estimated

dates for beginning and end of each training phase. The Contractor shall be responsible for the cost of the training program. The Owner shall be responsible for the trainee salaries and overhead costs.

C. Calibration Certificate Forms: See following forms.

SAMPLE
CALIBRATION CERTIFICATE

Job Name: _____ Contract No.: _____
Tag Number/Loop Number: _____
Loop Description: _____
Instrument Location: _____
Manufacturer: _____
Model Number _____
Adjustable Range: _____
Calibrated Range: _____
Remarks: _____

Installation Per Manufacturer's Requirements? Yes No
Installation Per Contract Documents? Yes No
If "No", explain: _____

Calibration Test:

	Input (Units)	Output (Units)	Accuracy
0%			
10%			
25%			
50%			
75%			
90%			
100%			

Switch Test:

	Setting	Deadband	Switch Point Upscale	Switch Point Downscale
Setpoint 1				
Setpoint 2				
Setpoint 3				
Setpoint 4				

CALIBRATION CERTIFICATE (cont.)

I hereby certify that the above information is correct and accurate, to the best of my knowledge, and that the instrument indicated above has been supplied, installed, calibrated, and tested in accordance with the manufacturer's recommendations and the Contract Documents, unless otherwise noted.

Receipt of this Calibration Certification shall in no way imply acceptance of any work or instrument supplied as a part of this Contract.

CONTRACTOR'S Signature: _____ Date: _____
CONTRACTOR'S Printed Name: _____

System Integrator's
Authorized Manufacturers
Representative Signature: _____ Date: _____

Representative Printed Name: _____
Phone Number: _____

Tester's Signature: _____ Date: _____
Tester's Printed Name: _____
Phone Number: _____

END OF SECTION 40 9000

SAMPLE LOOP VALIDATION/INSPECTION FORM

Client Name — Loop Validation / Inspection Test

Project Location:			
Contract Number:	**Loop Number/Description:**	**Tag Number:**	
PLC Description:			**Page ____ of ____**

DISCRETE I/O CHECKOUT

DP Initials	I/O Point Description	PLC	OIT	HMI	Notes/Remarks

ANALOG I/O CHECKOUT

DP Initials	I/O Signal Description	PLC	OIT	HMI	Notes/Remarks

Span	Desired	Actual	% Variation
0%			
25%			
50%			
75%			
100%			

Span	Desired	Actual	% Variation
0%			
25%			
50%			
75%			
100%			

Loop Validated Signatures	CONTRACTOR	DESIGN PROFESSIONAL (DP)	OWNER'S REPRESENTATIVE
	Name:	Name:	Name:
	Initials: Date:	Initials: Date:	Initials: Date:

SECTION 40 9100

PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Scope:
   1. Contractor shall furnish, install, calibrate, test, adjust, and place into operation the primary sensors and field instruments as shown on the Drawings and specified herein to the satisfaction of Owner.
   2. The Drawings and Specifications illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping, and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, accessories, and labor required for a complete, workable, and integrated system.
   3. Contractor shall be responsible for installing in-line pressure and flow elements and for providing taps in the process piping systems for installation of other flow and pressure sensing instrumentation.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

C. Related Sections:
   1. Section 40 9513, Control Panels

1.2 REFERENCES

A. AMSE B40.100, Pressure Gauges and Gauge Attachments

B. ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

C. ASTM A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

D. ASTM A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

E. ASTM B88, Standard Specification for Seamless Copper Water Tube

F. National Accreditation of Measurement and Sampling (NAMAS)

G. NEMA 250, Enclosures for Electrical Equipment

H. National Institute of Standards and Technology (NIST)

1.3 SUBMITTALS

A. Comply with Section 40 9000, Instrumentation and Control System General Requirements

PART 2 - PRODUCTS

2.1 IDENTIFICATION TAGS

A. Type: White engraved phenolic

B. Function: Identify specific characteristics of all sensors and field instruments. All instruments, whether field or panel mounted, shall have an identification tag.

C. Performance Requirements:
1. Tag numbers of sensors and field instruments shall be as shown on the drawings and as specified. For items not shown or specifically tagged, the item tag number shall be established by the system supplier.
2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.
3. The tags shall be fastened to the device with self-tapping stainless steel screws. Where fastening with screws cannot be accomplished secure with 1/8 inch stranded stainless steel wire rope and secured with a crimp sleeve. Provide hole in end of tag for attachment of wire.
4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel. Panel mounted devices shall have the tag attached to the rear of the device.

D. Construction Features:
1. Tags shall be engraved with 3/16-inch letters and constructed as follows:
a. 1/8- inch thick laminated phenolic for engraving composed of core laminated on both sides with a matte (non-glare) finish cover sheet
b. Core to be black; cover sheet to be white
c. Mounting holes to be centered on width and 1/4 inch from each end

2.2 LEVEL INSTRUMENTATION

A. RADAR LEVEL METER
1. Type: Non-contact system using a microwave transmitter/receiver, a horn or rod antenna and a microprocessor-based signal processor. Frequency modulated continuous wave of electromagnetic energy is transmitted through the antenna towards the surface of the material to be measured and energy is reflected back in the form of echoes. The transit time of the reflected radar signal is measured and evaluated in the signal processor. The level (or volume) of the material is read out in engineering units.
2. System Performance Requirements:
a. Accuracy:
1) Less than 32 feet: +/- 0.6 inches or better
2) Greater than 32 feet: +/- 0.3 percent of span or better
b. Maximum range: 65 feet
c. Repeatability: +/- 0.1% or better
d. Frequency: 25 GHz
e. Modulation: Frequency Modulated Continuous Waveform (FMCW)
f. Power Requirements: 24 VDC loop power
g. Transmitter analog output: 4 to 20 mA, 750 ohm maximum load
h. Transmitter digital output protocol: HART

i. Ambient Temperature: +15 to 25°C

3. Required Features:
   a. Antenna:
      1) Mountings: Flange mounting
      2) Rod Antenna Material: PTFE
      3) Flange and mounting hardware material: Type 316 stainless steel
      4) Maximum transmitter power: 30 microwatts
   b. Transmitter/Processor:
      1) Enclosure: Copper-free Aluminum, epoxy coated, NEMA 6, IP67
      2) Operator Control: Illuminated LCD. Programming by keypad or non-invasive programming using handheld programmer or magnetized probe
      3) Memory: non-volatile ROM/EEPROM
   c. Accessories:
      1) Handheld programmer
4. Manufacturer and Model:
   a. Series SITRANS LR250 as manufactured by Siemens
   b. Or approved equal

B. LIQUID POINT-LEVEL SWITCH
1. Function: To sense specific level for a process fluid by means on RF admittance technology. An output relay is actuated when the sensing element comes in contact with the process fluid.
2. Features:
   a. Field selectable for low or high level detection.
   b. Sensing element material: Suitable for the process liquid.
   c. Mounting: ¾" NPT for mating to non-metallic flange.
   d. NEMA 4X/IP66 Housing
   e. Area classification: General purpose
3. Electrical Characteristics:
   a. Electronics mounted integral to sensor
   b. Single DPDT relay contacts rated at 5A @ 120VAC
   c. Relay time delay adjustable up to 60 seconds response time
   d. Input Power: 19-250VAC, 18-200VDC, auto sensing
4. Manufacturer and Model:
   a. Model ThePoint as manufactured by AMETEK Drexelbrook
   b. Or approved equal

C. FLOAT SWITCH
1. Type: Direct acting, pear shaped, eccentric weighted, displacement type liquid level sensor
2. Construction Features:
   a. Float Body: Hollow hermetically sealed, rigidly molded of polypropylene containing mechanical switch and eccentric metal weight
   b. Mechanical Switch: SPDT switch rated 10 A resistive at 120 VAC and 5 A resistive at 30 VDC
   c. Weight: Weight to cause sensor to hang straight down from cable when not immersed and only allow float to pivot when immersed in liquid of specific gravity 1.0. External weights or floats that completely rise to the surface will not be permitted.
   d. Electrical Cable:

1) Heavy duty, 3 conductor, flexible and submersible cable, sheathed in PVC or chlorinated polyethylene rubber and connected to float and switch with watertight seal
2) Manufacturer's continuous length cable furnished shall be of sufficient length to extend to junction box.

3. Manufacturer and Model:
   a. Model ENM-10 as manufactured by ITT Flygt
   b. Or approved equal

D. WET FLOOR DETECTION SWITCH
1. Type: A direct acting float that moves up and down a stationary stem or rod surrounded by a permeable shield for protection and to minimize sloshing. The float shall rise or lower with liquid level and activate a magnetic switch within the stem or rod.
2. Features:
   a. Float body: 316 Buna N with magnet in float for actuating switch in rod. Float shall rise when immersed in water.
   b. Mechanical switch inside of rod: Hermetically sealed reed switch
   c. Rod material: Type 316 stainless steel
   d. Slosh and Protection Shield: Polycarbonate Plastic
3. Manufacturer and Model:
   a. LS-270 Series as manufactured by Gems Sensors
   b. Or approved equal

E. WET FLOOR DETECTION SWITCH (CHEMICAL AREAS)
1. Function: To detect wet floors in the chemical containment areas.
2. Type: A direct acting float that moves up and down a stationary stem or rod. The float shall rise or lower with liquid level and activate a magnetic switch within the stem or rod.
3. All wetted components shall be fully compatible for continuous immersion in chemical solutions.
4. Features:
   a. Float body: CPVC with magnet in float for actuating switch in rod. Float rises when immersed in water.
   b. Mechanical switch inside of rod: Hermetically sealed reed switch.
   c. Rod material: CPVC
   d. Mounting Bracket: Provide a wall mount bracket constructed of chemically-compatible material. Bracket shall position detector as close to floor as possible and allow full adjustment of detector position.
5. Manufacturer and Model:
   a. LS-74780 Series as manufactured by Gems Sensors.
   b. Or approved equal

F. SUBMERSIBLE LEVEL TRANSMITTER
1. Type: Submersible piezoresistive element measuring the level with reference to atmospheric pressure.
2. Performance Requirements:
   a. Accuracy: +/- 0.25% full scale
   b. Range: See Schedule
   c. Power: 12-30VDC loop power
   d. Transmitter Output: 4-20mADC, 2-wire loop powered
   e. Temperature Range: 0-180°F
   f. Pressure Limit: 2x full scale

3. Required Features:
    a. Mounting: As shown on the drawings.
    b. Housing: 316SS with 1/2" NPT and ETFE Cable
    c. Electrical Protection: Lightning and Surge protection
4. Manufacturer and Model:
    a. Model PBLT2 by Dwyer Instruments
    b. Or approved equal

2.3 FLOW INSTRUMENTATION

A. MAGNETIC FLOWMETER

1. General:
    a. Flowtube: Produce low level, high impedance pulsed DC signal proportional to the rate of fluid flow using the principle of electromagnetic induction.
    b. Pulsed DC Magnetic Flow Transmitter: Drive the flowtube coils with pulsed DC power and convert the flowtube output signal into a DC current output proportional to the flow rate.
2. System (Flowtube and Transmitter) Performance Requirements:
    a. Flow Range: As specified in the Instrument Schedule
    b. System Accuracy (with Analog Output): +/- 0.55% of flow rate or better over range from 2 fps to 33 fps
    c. System Repeatability: +/- 0.15% of flow rate or +/- 0.15 fps, whichever is greater
    d. Drift: Complete 0 stability
    e. Minimum Fluid Conductivity Limit: 5 micromho per centimeter or less
    f. Transmitter Outputs:
        1) 4 to 20 mA, direct acting and isolated
        2) High accuracy, field adjustable scaled pulse output to drive local totalizer
    g. Power Consumption: Not to exceed 20 VA for flowtube and transmitter combined
    h. Operating Temperature: Suitable for operation with process fluid temperature from -23 to 140°F
    i. Pressure Rating: Greater than or equal to test pressure specified in Section 40 0513, Exposed Piping Installation, for appropriate piping system
3. Construction and Required Features:
    a. Flowtube:
        1) Type: Lined metal flowtubes
        2) Size: As specified in the Instrument Schedule
        3) Interchangeability: Ratio of flow velocity to voltage reference signals generated shall be identical for all meter sizes to permit interchangeability with transmitter without requiring circuit modifications.
        4) System accuracy specified above shall be proven by submittal of flow test curves of the actual meters being furnished.
        5) Test curves shall show a minimum of 8 equally spaced flow points. Tests shall be performed using water and a weight or volume tank, or reference meters that are traceable and calibrated to NAMAS or NIST standards.
        6) Tube Material:
            a) Meter tubes 12 inches and smaller: Type 304 stainless steel
            b) Metering tubes 14 inches and larger: Type 304 stainless steel, 0.125-inch wall thickness or greater
        7) Electrodes Material: Type 316 stainless steel, unless otherwise specified in the Instrument Schedule

8) Lining: Teflon®, Elastomer, Neoprene, or polyurethane unless otherwise specified in the Instrument Schedule
9) Enclosure:
a) Materials and Rating: Stainless steel, polyurethane coated sheet steel, or cast low-copper aluminum alloy NEMA 6P, submersible to 33 feet
b) Finish: Finish exterior, except for flange faces, with a high build epoxy paint
10) End Connections: ANSI Class 150 pounds flange suitable for mating with pipe specified
11) Electrical Connections: 1/2-inch NPT tapped holes for power conduit fitting and signal conduit fittings

b. Pulsed DC Magnetic Flow Transmitter:
1) Solid state construction
2) Pulse and analog output with superimposed HART communication protocol. Outputs shall be galvanically isolated from input and earth ground
3) Automatic zeroing feature making it unnecessary to zero the instrument before or after placing it in operation
4) Precalibrated span adjustment providing continuous span adjustment over entire range
5) Enclosure:
a) NEMA 4
b) Finish: Epoxy coating
6) Mounting:
a) All transmitter and driver electronics shall be remotely mounted from the flow tubes at locations shown on the Drawings.
b) Provide complete stainless-steel mounting hardware
c) Type of mounting (wall, support frame or pipe stand) as required
7) Local Indication:
a) 8-character minimum LCD with field selectable engineering units
8) Power Requirements: 115 VAC +/- 10%, 60 Hz, +/- 3 Hz power supply

c. Accessories:
1) Manufacturer's recommended cables of sufficient length for connection between flowtube and transmitter electronics
2) Type 316 stainless steel grounding rings for flowtubes
3) Type 316 stainless steel grounding straps
4) Provide a NEMA 4X rated 120 VAC power on-off switch.
5) Provide spool piece for replacement of each different size flow tube where no bypass piping is provided.
6) Provide 1 calibrator suitable to calibrate all flow tubes provided.

4. Manufacturer and Model:
a. Sitrans Series 5100 flow tube and 5000 Series transmitter as manufactured by Siemens
b. Or approved equal

B. CLAMP-ON FLOWMETER
1. General
a. The meter shall be a clamp-on design which mounts externally to the pipe and with no liquid contact.
b. The meter shall utilize the transit-time measurement technique and employ the use of two microprocessors.

c. The meter shall also employ an alternate Doppler measurement technique for liquids with high solid content. The meter shall automatically toggle from transit time to Doppler measurement if the signal decays due to high solids content and toggle back once the signal improves. The time delay for the toggle feature shall be programmable.
d. Transducers shall be supplied with multi-point wet flow calibration certificate and shall have an accuracy of +/- 1%.

2. Transducer Features
   a. Transducers shall have built-in RTD for measuring the transducer block temperature and automatically compensating for temperature effects including changes in fluid viscosity and density.
   b. Transducers shall be encased in stainless steel with an integral armored stainless steel jacketed TRIAX cable. The use of COAX and BNC cable is not acceptable.
   c. Transducers shall be mounted in a full sealed stainless steel mounting track and have the ability to be coupled using permanent coupling pads. Use of grease is not acceptable.
   d. Transducer markings shall be laser scribed and solvent resistant. Use of adhesive labels is not acceptable.
3. Meter features
   a. The meter shall have the ability to automatically recognize the transducers when they are connected.
   b. The meter shall not require a "zero calibration" in the field. The zero calibration shall be factory pre-set and certified prior to shipment.
   c. The meter shall have the ability to automatically calculate the Reynolds number and corresponding flow regime (laminar, turbulent, and transitional).
   d. The meter shall provide automatic liquid sonic velocity compensation, and have built in liquid tables for liquid viscosity and density settings.
   e. The meter electronics shall be housed in a NEMA4X enclosure and shall display flow rate, flow velocity, mass flow, total flow, signal strength, signal quality, liquid sonic velocity, and the flow regime.
   f. The meter shall be capable of outputting multiple 4-20ma signals, voltage 0-1 V or 0-10 V high precision frequency 0-1 kHz or 0-10 kHz galvanically isolated, RS-232, RS-484, binary output pulse of alarm for relay total and meter status.
   g. The meter shall have the ability to status alarm for conditions of fault, flow direction, sound velocity limit, and flow velocity limit.
   h. The meter shall have the ability to set the 4-20 ma signal to a settable status and alarm condition.
   i. The meter shall have RS-232 output and internal memory with a minimum storage of 100,000 data points.
4. Accessories
   a. Provide all necessary straps and anchors to affix the transducers to the pipe and meter to the wall.
   b. Provide all necessary cables for connection between the transducers and the meter.
5. Sizes and Ratings
   a. System Accuracy: ±1.0 percent of rate from 0 to 100 percent of range.
   b. Meter shall read within the prescribed accuracy with fluid velocities from 0.01 feet per second to 57 feet per second.
   c. Drift: Complete zero stability.
   d. Process Fluid Temperature: 40 to 120 deg F
6. Warranty

a. Strap on flowmeter shall include a minimum 1 year factory warranty. Field service shall be included at no additional cost during the warranty period.

7. Manufacturer: Subject to compliance with the requirements of this specification, available manufacturers of clamp-on flow meters include, but are not limited to, the following:
   a. Flexim 7407
   b. Or approved equal

C. CHEMICAL FLOWMETER

1. Provide flow sensors to assure that chemical is being delivered. Sensors shall be installed at the point of injection and shall operate from 50% to 150% of the typical service flow as show in the flow meter schedule.
2. Materials of Construction
   a. Body: 316 SST
   b. Pistons: Carbon
   c. Bearing: Rulon
   d. O-rings: Teflon
3. Minimum Accuracy:
   a. +/- 5% at flowrates of 7 to 29 mL/min
   b. +/- 10% at flowrate of 3 to 90 mL/min
4. Manufacturer:
   a. Max Machinery, Model 234, with 4-20 mA output

2.4 PRESSURE INSTRUMENTATION

A. DIGITAL PRESSURE TRANSMITTER/SWITCH

1. Type: Gauge pressure.
2. Function: Provide analog output signal directly proportional to sensed pressure.
3. Performance Specifications:
   a. Adjustable Range: See Instrument Schedule
   b. Number of Switches and Setpoints: One.
   c. Setpoint Accuracy: 0.5% of full range span.
   d. Power Supply: 10-36Vdc loop-power.
   e. Outputs:
      1) Analog: 4-20mAdc isolated.
      2) Discrete: SPST rated for 300mA @ 120VAC
4. Required Features:
   a. Repeatability: 0.1% of full range span.
   b. Programmable response time delay: 2 seconds minimum.
   c. Programmable for automatic or manual reset.
   d. Field adjustable setpoint over full range by means of external touchpad.
   e. Display: 0.5” 4-digit (minimum), LCD.
   f. Screw type terminals.
   g. ½” NPT female process connection.
   h. ½” NPT female electrical connection.
   i. Pressure sensor element shall be 316SS.
   j. NEMA 4X epoxy-coated aluminum enclosure.
   k. Programming and data shall be protected by non-volatile EEPROM.
5. Manufacturers:
   a. United Electric Controls, One Series.
   b. Or approved equal

B. PRESSURE TAPS, SENSING LINES, AND ACCESSORIES

1. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters:
   a. Material: Copper Water Tube, ASTM B88, Type L, drawn temper or annealed
   b. Pressure Rating: 150 psi
   c. Size: 1/2-inch outer diameter for water
   d. Connections: Brass Compression Type, "Swagelok" by Crawford, or approved equal
   e. Shut-off Valves:
      1) Type: Ball
      2) Pressure Rating: 150 psi
      3) Body, Ball and Stem: Brass
      4) Packing: High Density TFE
      5) Handle: Nylon with metal travel stops
      6) Support Rings: TFE coated brass
      7) End Connections: Removable "Swageloks"
      8) Model: Whitey Series 40 for water, or approved equal
   f. Manifolds:
      1) Type: 5-valve and 3-valve meter manifolds
      2) Materials: 316 SS Body, Bonnets and Stems; Delrin seats; Teflon Packing
      3) Manufacturer: Anderson-Greenwood, or approved equal
2. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters:
   a. Material: Type 316 Stainless Steel Tubing, ASTM A269, Medium Wall Thickness
   b. Pressure Rating: 150 psi
   c. Size: 3/8-inch outer diameter for air
   d. Connections: 316 Stainless Steel Compression Type, "Swagelok" by Crawford, or approved equal
   e. Shut-off Valves:
      1) Type: Ball
      2) Pressure Rating: 150 psi
      3) Body, Ball and Stem: Type 316 Stainless Steel
      4) Packing: High Density TFE
      5) Handle: Nylon with metal travel stops
      6) Support Rings: TFE coated Type 316 stainless steel
      7) End Connections: Removable "Swageloks"
      8) Model: Whitey Series 40 for air, or approved equal
3. Manifolds:
   a. Type: 5-valve and 3-valve meter manifolds
   b. Materials: Type 316 stainless steel Body, Bonnets and Stems; Delrin seats; Teflon Packing
   c. Manufacturer: Anderson-Greenwood, or approved equal
4. Pressure Tap Sensing Lines and Accessories for Pressure Switches and Pressure Gauges:
   a. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:
      1) Material and Fittings: Type 304L Stainless Steel Pipe (ASTM A312) and threaded fittings and adapters (ASTM A403) in accordance with Section 40 0513, Process Piping.
      2) Sizes: 1/2 inch minimum for main sensing piping and 1/4-inch gauge and switch connections
      3) Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Schedule in Section 40 0513, Process Piping.
      4) Accessories:

a) For applications not requiring diaphragm seals, provide separate 1/2-inch stainless steel threaded ball valve for each gauge and switch.
b) For applications requiring diaphragm seals, provide separate 1/2-inch threaded stainless-steel ball valve for seal process side shutoff. Ball valves shall be provided in accordance with the specifications in Section 40 0523, Process Valves, Gates, and Accessories.

b. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
1) Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. PVC pipe and fittings shall be provided in accordance with the requirements of Section 40 0513, Process Piping.
2) Sizes: 1/2 inch minimum for main process sensing piping and 1/4 inch for gauge and switch connections
3) Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 40 0513, Process Piping.
4) Accessories:
a) For copper piping system taps with or without seals, provide a separate 1/2-inch minimum threaded brass or bronze ball valve for each gauge and switch.
b) For PVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded PVC ball valve for process sensing line shutoff. Ball valves shall be provided in accordance with the specifications in Section 40 0523, Process Valves, Gates, and Accessories.

C. DIAPHRAGM SEAL
1. General: Furnish diaphragm seals for pressure gauges and switches at locations shown and as specified.
2. Required Features:
a. Provide fill/bleed screw to permit filling of instrument and diaphragm seal
b. Instrument Connection: 1/4-inch NPT
c. Process Connection: 1/2-inch NPT
d. Working Pressure Rating: Equal to or greater than the attached gauge or switch operating pressure specified in Exposed Piping Schedule in Section 40 0513, Process Piping, whichever is greater
e. Bolting Materials: Type 316 stainless steel
f. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
3. Construction Features:
a. Top Housing: Type 316 stainless steel
b. Diaphragms, O-rings and Gaskets:

Process Fluid	Diaphragm	O-Ring	Gasket
Chlorine Gas	Teflon	Teflon	Teflon
Chlorine Solution	Teflon	Teflon	Teflon
Alum	Teflon	Teflon	Teflon
Lime	316 SS	Teflon	Teflon
Sodium Hypochlorite	Teflon	Teflon	Teflon
Sludge	316 SS	Buna-N	Buna-S

c. Process Side Housing Material: 316 stainless steel for metallic piping; PVC or CPVC to match non-metallic piping
d. Sensing Liquid: Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Flurolube 63.

4. Assembly and Calibration:
   a. The complete diaphragm seal assembly, including gauge, switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch setpoints specified prior to shipment.
   b. CONTRACTOR shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gauge, switch or transmitter accuracy over the specified measurement range or at switch setpoints.
   c. Location and orientation of the gauges, switches and seal assemblies shall be coordinated with the actual piping and equipment installations so that gauges and indicators shall be easily read and accessed for maintenance by plant personnel.
5. Manufacturer and Model:
   a. Type 101 as manufactured by Ashcroft
   b. Or approved equal

2.5 TEMPERATURE INSTRUMENTATION

A. DIGITAL TEMPERATURE TRANSMITTER

1. Function: Provide analog output signal directly proportional to sensed temperature.
2. Performance Specifications:
   a. Adjustable Range: See Instrument Schedule
   b. Number of Switches and Setpoints: One.
   c. Setpoint Accuracy: 0.5% of full range span.
   d. Power Supply: 10-36Vdc loop-power.
   e. Outputs:
      1) Analog: 4-20mAdc isolated.
      2) Discrete: SPST solid state rated for 600mA @ 120VAC
3. Required Features:
   a. Repeatability: 0.1% of full range span.
   b. Programmable response time delay: 2 seconds minimum.
   c. Programmable for automatic or manual reset.
   d. Field adjustable setpoint over full range by means of external touchpad.
   e. Display: 0.5” 4-digit (minimum), LCD.
   f. Screw type terminals.
   g. ½” NPT female process connection.
   h. ½” NPT female electrical connection.
   i. Temperature sensor element shall be 316SS.
   j. NEMA 4X epoxy-coated aluminum enclosure.
   k. Programming and data shall be protected by non-volatile EEPROM.
4. Sensor: Provide local sensor unless shown otherwise on the Drawings.
5. Manufacturers:
   a. United Electric Controls, One Series.
   b. Or approved equal

2.6 ANALYTICAL INSTRUMENTATION

A. RESIDUAL CHLORINE ANALYZER

1. Description: Amperometric chlorine probe for reagentless free chlorine measurement.
2. Analyzer
    a. Number of Sensors: Up to four (4)
    b. Number of Analog Outputs: Up to four (4)
    c. Display: 4" minimum, color.
    d. Power: 120V
    e. Output: 4-20 mA
    f. Enclosure: NEMA 4X FRP
    g. Maximum Dimensions: 11" x 13" x 6" (W x H x D)
    h. Note: Where possible combine multiple sensors/probes on a single analyzer/transmitter.
3. Probe
    a. Type: Membrane-covered amperometric three-electrode system
    b. Measured: Free residual chlorine
    c. Probe range: 0.05 -5 mg/L
    d. Resolution: 0.01 mg/L
    e. Reproduction: ±5%
    f. Stability: -1% per month (without calibration)
    g. Working electrode: Gold catholde
    h. Counter electrode: SST anode
    i. Reference electrode: silver/silver halide
    j. Temperature range: 41 to 113 degrees F
    k. pH Range: 4-9 s.u.
    l. First polarization time: 120 minutes
    m. Re-polarization time: 30 minutes
    n. Calibration: Manual using DPD
    o. Housing Material: PVC
4. Accessories:
    a. Flow cell: Provide a polycarbonate flow cell and backplate. Provide dual flow cell in instances where two probes are required. Mount using 304 SST hardware.
5. Spare Parts:
    a. Two (2) membrane caps per chlorine sensor.
6. Product and Manufacturer:
    a. Chemtrac HydroACT HA4 analyzer, CP4 probe.
    b. Foxcraft FX-CL-F analyzer, 301254X probe.

B. pH/OXIDATION REDUCTION POTENTIAL (ORP) ANALYZERS

1. Description: Three electrode (process, reference, and ground) differential pH/ORP probe and a microprocessor-based analyzer/transmitter designed to measure pH/ORP of the sample and produce a proportional output signal linear to the pH/ORP.
2. Analyzer
    a. Number of Sensors: 4
    b. Number of Analog Outputs: 4
    c. Display: 4" minimum, color.
    d. Power: 120V
    e. Output: 4-20 mA
    f. Enclosure: NEMA 4X
    g. Maximum Dimensions: 11" x 13" x 6" (W x H x D)
    h. Note: Where possible combine multiple sensors/probes on a single analyzer/transmitter.

3. pH Probe
    a. Type: W-type rod membrane, pH electrode
    b. Measured: pH
    c. Probe range: 0 – 14 s.u.
    d. Slope: 95 – 102%
    e. Stability: < -0.01 s.u. per hour (without calibration)
    f. Reproducibility: < 0.01 s.u
    g. Working electrode: Gold catholde
    h. Counter electrode: SST anode
    i. Reference electrode: silver/silver halide
    j. Temperature range: 41 to 113 degrees F
    k. pH Range: 4-9 s.u.
    l. First polarization time: 120 minutes
    m. Re-polarization time: 30 minutes
    n. Calibration: Manual using DPD
    o. Housing Material: PVC
4. Accessories:
    a. Flow cell: Provide a polycarbonate flow cell and backplate. Provide dual flow cell in instances where two probes are required. Mount using 304 SST hardware.
5. Materials
    a. Sensor
        1) Body and salt bridge: PEEK.
        2) Junction: Kynar.
        3) Process electrode: Glass (pH), glass and platinum (ORP).
        4) Ground electrode: Titanium.
        5) O-ring seals: Viton.
    b. Analyzer/Transmitter Enclosure: NEMA 4X.
    c. Insertion Mounting Assembly: Stainless steel, type 316.
6. Ratings and Performance
    a. Sensor
        1) Range: 0 to 14 pH; -1500 to +1500 mV ORP.
        2) Sensitivity: +/- 0.01 pH; +/- 0.5 mV ORP.
        3) Stability: 0.03 pH; 2mV ORP per 24 hours, non cumulative.
        4) Operating temperature: 23 to 158 degrees F.
        5) Maximum pressure: 100 psi at 158 degrees.
        6) Maximum flow rate: 10 fps.
    b. Analyzer/Transmitter
        1) Repeatability: 0.05% of span.
        2) Stability: 0.05% of span for 24 hours, non-cumulative.
        3) Analog outputs: 4 to 20 mA isolated.
        4) Ambient temperature range: -4 to 104 deg F.
        5) Relative humidity: 0 to 95% non-condensing.
        6) Input power: 120 V a. c., 35W maximum.
        7) Output contacts: 120 V a. c., 5 Amp resistive maximum.
        8) Analog outputs: 500 Ohms maximum impedance.
7. Product and Manufacturer
    a. Hach pHD Series pH/ORP sensor and sc200 analyzer/transmitter.
    b. Rosemount 389VP sensor and 1056 analyzer/transmitter.

C. CONDUCTIVITY ANALYZERS

1. Description: Inductive conductivity sensor that induces a low current in a solution and measures the magnitude of the current to determine the conductivity.
2. Features
    a. Sensor
        1) Non-contacting inductive sensor.
        2) Internal platinum RTD for temperature compensation.
        3) Insertion mounting.
        4) Nominal 1/2-inch bore diameter.
    b. Analyzer/Transmitter
        1) Solid state, microprocessor-based.
        2) Non-volatile memory for all user settings.
        3) Capable of operating with up to two sensors.
        4) Two independent PID controllers.
        5) Plug and play operation, automatically detects sensor type.
        6) Built-in data logger, stores 6 months of data at 15-minute intervals with 2 sensors.
        7) Two analog outputs.
        8) Three SPDT alarm/control relays.
        9) LCD graphic display with LED backlighting.
3. Accessories
    a. Digital gateway.
    b. Extension cable.
    c. Insertion mounting assembly with ball valve, 2 inch NPT.
4. Materials
    a. Sensor Body: Teflon.
    b. Analyzer/Transmitter Enclosure: NEMA 4X.
    c. Insertion Mounting Assembly: Stainless steel, type 316.
5. Ratings and performance
    a. Sensor
        1) Range: 0-200 up to 0-2,000,000 microSiemens/cm.
        2) Sensitivity: +/- 0.01 pH; +/- 0.5 mV ORP.
        3) Stability: 0.03 pH; 2mV ORP per 24 hours, non cumulative.
        4) Operating temperature: 14 to 392 deg F.
        5) Maximum pressure: 200 psi.
        6) Maximum flow rate: 10 fps.
    b. Analyzer/Transmitter
        1) Repeatability: 0.05% of span.
        2) Stability: 0.05% of span for 24 hours, non-cumulative.
        3) Analog outputs: 4 to 20 mA isolated.
        4) Ambient temperature range: -4 to 104 deg F.
        5) Relative humidity: 0 to 95% non-condensing.
        6) Input power: 120 V a. c., 35W maximum.
        7) Output contacts: 120 V a. c., 5 Amp resistive maximum.
        8) Analog outputs: 500 Ohms maximum impedance.
6. Product and Manufacturer
    a. Hach 3700 sensor and sc200 analyzer/transmitter.
    b. Rosemount 400VP and 1056 analyzer/transmitter.

D. FLUORIDE ANALYZER
1. Description: Ion selective electrode to monitor fluoride ion concentration in potable water.

2. Analyzer
    a. Number of Sensors: 1
    b. Number of Analog Outputs: 1
    c. Display: 3 digit red LED.
    d. Power: 120V
    e. Output: 4-20 mA
    f. Enclosure: NEMA 4X Polycarbonate
    g. Maximum Dimensions: 11” x 8” x 5” (W x H x D)
3. Probe
    a. Type: Ion selective electrode (ISE)
    b. Measured: Fluoride
    c. Probe range: 0 - 10 mg/L
    d. Resolution: 0.01 mg/L
    e. Accuracy: ±0.2%
    f. Reference half cell: Silver/silver chloride, saturated KCl
    g. Primary Junction: Porous ceramic, statured KCl in crossed linked polymer
    h. Secondary Junction: Solid-state non-porous cross-linked conductive polymer embedded in HDPE/Kynar support matrix, excess saturated KCl salt system in cross linked polymer
    i. Temperature range: 41 to 122 degrees F
    j. pH Range: 5.5 - 9.5 s.u.
    k. Calibration: Manual (1 point offset)
    l. Material: Radel R-5000 NT
4. Accessories:
    a. Flow cell: Provide a 12” x 24” x ½” (H x W x D) PVC panel for mounting with a 0-25 psi pressure reducer, 0 – 5 gph rotometer with SST valve, brass barbed connectors for ¼” ID tubing, ½” SCH 80 PVC piping to keep sensor tip wet, 1” PVC pipe tee with twist lock sensor receptacle, and inlet and backpressure PVC ball valves.
5. Product and Manufacturer:
    a. Foxcraft FX-300-F analyzer, SF-8T-UL probe.

E. PHOSPHATE ANALYZER
1. Description: Analyzer to monitor orthophosphate concentration in potable water.
2. Analyzer/Probe
    a. Number of Sensors: 1
    b. Number of Analog Outputs: 1
    c. Power: 120V
    d. Output: 4-20 mA
    e. Serial Interface: RS-232
    f. Enclosure: NEMA 4X FRP
    g. Maximum Dimensions: 26” x 10” x 7” (H x W x D)
    h. Measured: Orthophosphate (as PO_4 or as PO_4-P)
    i. Probe range (as PO_4): 0.09 - 9 mg/L
    j. Probe range (as PO_4-P): 0.03 - 3 mg/L
    k. Cycle Time: 5 – 9999 minutes
    l. Accuracy: ±2% or 2x detection limit
    m. Temperature range: 41 to 131 degrees F
3. Accessories:

a. Reagents: Provide a sufficient amount of VMO reagent suitable for 12 months of operation at a 5 minute sample cycle. Provide reagent line priming package, reagent and cleaning solution bottle with connection lines, and reagent rack.

4. Product and Manufacturer:
   a. ChemScan mini oP

2.7 SCHEDULES

A. Schedule: See attachment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Items shall be inspected for damage upon delivery to the site.

B. Damaged components shall not be installed.

3.2 INSTALLATION

A. Contractor shall require the system supplier to furnish the services of qualified factory-trained servicemen to assist in the installation of the instrumentation and control system equipment.

B. Install each item in accordance with manufacturer's recommendations in accordance with the Contract Documents. Transmitters and instruments which require access for periodic calibration or maintenance shall be mounted so they are accessible while standing on the floor. Care shall be taken in the installation to ensure sufficient space is provided between instruments and other equipment or piping to allow for easy removal and servicing.

C. All items shall be mounted and anchored using stainless steel hardware unless otherwise noted.

D. All field instruments shall be rigidly secured to walls, stands, or brackets as required by the manufacturer and as shown on the Contract Drawings.

E. Conform to all applicable provisions of the NEMA standards, NEC, and local, State, and Federal codes when installing the equipment and interconnecting wiring.

END OF SECTION 40 9100

TYPE	TAG	LOOP #	PROCESS DESCRIPTION	RANGE	SETPOINT	LINE SIZE	SPEC
LEVEL	LIT	2002	BREAK TANK 1 LEVEL	0-30 FT	N/A	N/A	2.2 F
LEVEL	LIT	2003	BREAK TANK 2 LEVEL	0-30 FT	N/A	N/A	2.2 F
LEVEL	LSL	2006	BREAK TANK 1 LOW LEVEL SWITCH	N/A	EL. 752.00	N/A	2.2 C
LEVEL	LSL	2007	BREAK TANK 2 LOW LEVEL SWITCH	N/A	EL. 752.00	N/A	2.2 C
LEVEL	LIT	6100	SODIUM BISULFITE STORAGE TANK 1 LEVEL	0-8 FT	N/A	N/A	2.2 A
LEVEL	LIT	6101	SODIUM BISULFITE STORAGE TANK 2 LEVEL	0-8 FT	N/A	N/A	2.2 A
LEVEL	LSH	6103	SODIUM BISULFITE DAY TANK HIGH LEVEL SWITCH	N/A	6" < TOP	N/A	2.2 B
LEVEL	LSH	6140	SODIUM BISULFITE FEED ROOM WET FLOOR SWITCH	N/A	SEE DWGS	N/A	2.2 E
LEVEL	LIT	6200	SODIUM HYDROXIDE STORAGE TANK 1 LEVEL	0-11 FT	N/A	N/A	2.2 A
LEVEL	LIT	6201	SODIUM HYDROXIDE STORAGE TANK 2 LEVEL	0-11 FT	N/A	N/A	2.2 A
LEVEL	LSH	6203	CAUSTIC SODA DAY TANK HIGH LEVEL SWITCH	N/A	6" < TOP	N/A	2.2 B
LEVEL	LSH	6240	CAUSTIC SODA FEED ROOM WET FLOOR SWITCH	N/A	SEE DWGS	N/A	2.2 E
LEVEL	LIT	6300	ORTHOPHOSPHATE STORAGE TANK 1 LEVEL	0-11 FT	N/A	N/A	2.2 A
LEVEL	LIT	6301	ORTHOPHOSPHATE STORAGE TANK 2 LEVEL	0-11 FT	N/A	N/A	2.2 A
LEVEL	LSH	6303	ORTHOPHOSPHATE DAY TANK HIGH LEVEL SWITCH	N/A	6" < TOP	N/A	2.2 B
LEVEL	LSH	6340	ORTHOPHOSPHATE FEED ROOM WET FLOOR SWITCH	N/A	SEE DWGS	N/A	2.2 E
LEVEL	LSH	6402	ANTISCALANT DAY TANK HIGH LEVEL SWITCH	N/A	6" < TOP	N/A	2.2 B
LEVEL	LIT	6500	SODIUM HYPOCHLORITE STORAGE TANK 1 LEVEL	0-11 FT	N/A	N/A	2.2 A
LEVEL	LIT	6501	SODIUM HYPOCHLORITE STORAGE TANK 2 LEVEL	0-11 FT	N/A	N/A	2.2 A
LEVEL	LIT	6502	SODIUM HYPOCHLORITE DAY TANK LEVEL	0-5 FT	N/A	N/A	2.2 A
LEVEL	LIT	6503	SODIUM HYPOCHLORITE STORAGE TANK 3 LEVEL	0-11 FT	N/A	N/A	2.2 A
LEVEL	LSH	6504	SODIUM HYPOCHLORITE DAY TANK HIGH LEVEL SWITCH	N/A	6" < TOP	N/A	2.2 B
LEVEL	LSH	6540	SODIUM HYPOCHLORITE FEED ROOM WET FLOOR SWITCH	N/A	SEE DWGS	N/A	2.2 E
LEVEL	LIT	6600	FLUORIDE STORAGE TANK 1 LEVEL	0-8 FT	N/A	N/A	2.2 A
LEVEL	LIT	6601	FLUORIDE STORAGE TANK 2 LEVEL	0-8 FT	N/A	N/A	2.2 A
LEVEL	LSH	6603	FLUORIDE DAY TANK HIGH LEVEL SWITCH	N/A	6" < TOP	N/A	2.2 B
LEVEL	LSH	6640	FLUORIDE FEED ROOM WET FLOOR SWITCH	N/A	SEE DWGS	N/A	2.2 E
FLOW	FT	2002	ANTISCALANT FLOW	0-3.31 gph	N/A	SEE DWGS	2.3 C
FLOW	FIT	2004	NF BYPASS FLOW	0-10 MGD	N/A	SEE DWGS	2.3 A
FLOW	FIT	5200	NFB TO DEGASIFIERS FLOW	0-10 MGD	N/A	SEE DWGS	2.3 A
FLOW	FIT	5205	BLENDED WATER FLOW	0-25 MGD	N/A	SEE DWGS	2.3 B
FLOW	FIT	6504	SODIUM HYPOCHLORITE DILUTION WATER FLOW	0-200 gpm	N/A	SEE DWGS	2.3 A
PRESSURE	PIT	2000	BREAK TANK PUMP DISCHARGE HEADER PRESSURE	0-75 PSI	N/A	SEE DWGS	2.4 A
PRESSURE	PIT	2001	NF FEED PUMPS SUCTION HEADER PRESSURE	0-75 PSI	N/A	SEE DWGS	2.4 A
PRESSURE	PIT	2005	NF BYPASS HEADER PRESSURE	0-75 PSI	N/A	SEE DWGS	2.4 A
PRESSURE	PIT/PSH	2112	BREAK TANK PUMP 1 DISCHARGE PRESSURE	0-75 PSI	47 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	2132	BREAK TANK PUMP 3 DISCHARGE PRESSURE	0-75 PSI	47 PSI	N/A	2.4 A

TYPE	TAG	LOOP #	PROCESS DESCRIPTION	RANGE	SETPOINT	LINE SIZE	SPEC
PRESSURE	PIT/PSH	2142	BREAK TANK PUMP 4 DISCHARGE PRESSURE	0-75 PSI	47 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	2162	BREAK TANK PUMP 6 DISCHARGE PRESSURE	0-75 PSI	47 PSI	N/A	2.4 A
PRESSURE	PDIT	2212	CARTRIDGE FILTER 1 DIFFERENTIAL PRESSURE	0-75 PSI	N/A	N/A	2.4 A
PRESSURE	PDIT	2222	CARTRIDGE FILTER 2 DIFFERENTIAL PRESSURE	0-75 PSI	N/A	N/A	2.4 A
PRESSURE	PDIT	2232	CARTRIDGE FILTER 3 DIFFERENTIAL PRESSURE	0-75 PSI	N/A	N/A	2.4 A
PRESSURE	PDIT	2242	CARTRIDGE FILTER 4 DIFFERENTIAL PRESSURE	0-75 PSI	N/A	N/A	2.4 A
PRESSURE	PIT/PSL	3101	NF FEED PUMP 1 SUCTION PRESSURE	0-75 PSI	15 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	3102	NF FEED PUMP 1 DISCHARGE PRESSURE	0-250 PSI	182 PSI	N/A	2.4 A
PRESSURE	PIT/PSL	3201	NF FEED PUMP 2 SUCTION PRESSURE	0-75 PSI	15 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	3202	NF FEED PUMP 2 DISCHARGE PRESSURE	0-250 PSI	182 PSI	N/A	2.4 A
PRESSURE	PIT/PSL	3301	NF FEED PUMP 3 SUCTION PRESSURE	0-75 PSI	15 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	3302	NF FEED PUMP 3 DISCHARGE PRESSURE	0-250 PSI	182 PSI	N/A	2.4 A
PRESSURE	PIT/PSL	3401	NF FEED PUMP 4 SUCTION PRESSURE	0-75 PSI	15 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	3402	NF FEED PUMP 4 DISCHARGE PRESSURE	0-250 PSI	182 PSI	N/A	2.4 A
PRESSURE	PIT/PSL	3501	NF FEED PUMP 5 SUCTION PRESSURE	0-75 PSI	15 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	3502	NF FEED PUMP 5 DISCHARGE PRESSURE	0-250 PSI	182 PSI	N/A	2.4 A
PRESSURE	PIT/PSL	3601	NF FEED PUMP 6 SUCTION PRESSURE	0-75 PSI	15 PSI	N/A	2.4 A
PRESSURE	PIT/PSH	3602	NF FEED PUMP 6 DISCHARGE PRESSURE	0-250 PSI	182 PSI	N/A	2.4 A
PRESSURE	PDIT	5112	DEGASIFIER 1 INLET FILTER DIFFERENTIAL PRESSURE	per mfg	per mfg	N/A	2.4 A
PRESSURE	PDIT	5122	DEGASIFIER 2 INLET FILTER DIFFERENTIAL PRESSURE	per mfg	per mfg	N/A	2.4 A
TEMP	TIT	1000	ELECTRICAL ROOM TEMPERATURE	0-120 F	N/A	N/A	2.5 A
TEMP	TIT	3000	PROCESS ROOM TEMPERATURE	0-120 F	N/A	N/A	2.5 A
TEMP	TIT	6145	SODIUM BISULFITE FEED ROOM TEMPERATURE	0-120 F	N/A	N/A	2.5 A
TEMP	TIT	6245	CAUSTIC SODA FEED ROOM TEMPERATURE	0-120 F	N/A	N/A	2.5 A
TEMP	TIT	6545	SODIUM HYPOCHLORITE FEED ROOM TEMPERATURE	0-120 F	N/A	N/A	2.5 A
ANALYZER	AIT	2002	NF FEED ORP (PRE-INJECTION)	-1.5 - 1.5 V	N/A	N/A	2.6 B
ANALYZER	AIT	2003	NF FEED ORP (POST-INJECTION)	-1.5 - 1.5 V	N/A	N/A	2.6 B
ANALYZER	AIT	3020	NF CONCENTRATE CONDUCTIVITY	0-2 uS/cm	N/A	N/A	2.6 C
ANALYZER	AIT	3021	NF CONCENTRATE pH	0-14	N/A	N/A	2.6 B
ANALYZER	AIT	5201	BLENDED WATER pH	0-14	N/A	N/A	2.6 B
ANALYZER	AIT	5202	BLENDED WATER CHLORINE RESIDUAL	0-5 mg/L	N/A	N/A	2.6 A
ANALYZER	AIT	5203	BLENDED WATER FLUORIDE RESIDUAL	0-10 mg/L	N/A	N/A	2.6 D
ANALYZER	AIT	5204	BLENDED WATER PHOSPHATE RESIDUAL	0-9 mg/L	N/A	N/A	2.6 E

SECTION 40 9443

PLANT CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

B. Related Sections: The following sections contain requirements that relate to this section.
1. Division 26 Section “Basic Electrical Requirements”.
2. Division 26 Section “Basic Electrical Materials”.
3. Division 26 Section “Signal and Communication Cables”.
4. Division 26 Section “Wires, Cables, and Connectors”.
5. Division 40 Section “Instrumentation – General”.
6. Division 40 Section “Control Panels”.

1.2 DESCRIPTION OF WORK

A. General: Provide all labor, tools, equipment, and materials necessary for a complete and operational Plant Control System in accordance with the plans and as specified herein.

B. Contractor shall furnish all labor, materials, and components, and shall provide all design, assembly, testing, and start-up services required to provide a complete and operational programmable controller system (referred to herein as PLC) as specified and shown on the Drawings. The system includes, but is not necessarily limited to the following:
1. Processor modules.
2. Communication equipment.
3. Input/output (I/O) modules.
4. Operator interface equipment.
5. Mounting racks.
6. Power supplies.
7. Programming equipment.
8. Software.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of the National Electrical Code (NEC) and all other applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
1. National Electrical Manufacturers Association (NEMA).
2. Institute of Electrical and Electronic Engineers (IEEE).
3. American National Standards Institute (ANSI).
4. National Fire Protection Association (NFPA).
5. Underwriters' Laboratories (UL).
6. International Society for Measurement and Control (ISA).

C. Qualifications
   1. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of programmable logic controllers (PLCs) whose products have been in satisfactory use in similar service for not less than 5 years.
   2. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with materials and equipment similar to items specified herein.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data for all components.

B. Materials List: Submit a bill of materials listing quantities, manufacturer's name, and catalog numbers.

C. Wiring Diagrams: Submit wiring diagrams showing all connections for all equipment furnished under this section. Wire, terminal, and component labeling shall follow established facility conventions where applicable.

D. System Hardware and Software Documents: Furnish a system block diagram, I/O drawings, and control strategy descriptions. Turn over all factory software documentation and manuals to the Engineer after completion of field testing.

E. Dimensional Drawings: Furnish dimensional drawings for each piece of equipment to be provided.

F. Program Documentation: Submit annotated printouts of all PLC and Human Machine Interface (HMI) programs. Provide copies of all PLC and HMI programs on a flash drive.

G. Manufacturer's Data Sheet: Provide manufacturer's data sheet on all equipment including model numbers, serial numbers, ranges, scales, and a detail of each component.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Store the items furnished under this section in a manner that meets the requirements of the manufacturer until they can be installed. Use all means necessary to protect the material of this section before, during, and after installation, and to protect the installed work and materials of all other trades.

1.6 DEFINITIONS

A. Training Day: A training day is defined as 8 hours of classroom and hands-on instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday.

1.7 SCADA ALLOWANCE

A. The Contractor shall include in the bid an allowance for the purchase of computers, accessories, peripherals, and/or furniture for the Owner. These components shall be provided by the System Integrator. The Owner shall be able to select the computers, accessories, peripherals, and/or furniture during the shop drawing review process with technical input from the System Integrator.

PART 2 - PRODUCTS

2.1 SCADA SYSTEM

A. Programmable Logic Controller (PLC) Components:
   1. Rack Mounted:
      a. Processor Module: 1756-L81E
      b. Digital Input Module: 1756-IA16I
      c. Digital Output Module: 1756-OW16I
      d. Analog Input Module: 1756-IF8I
      e. RTD Analog Input Module: 1756-IR12
      f. Analog Output Module: 1756-OF8I
      g. Communication Module: 1756-EN2T
      h. Power Supply: 1756-PA75/B
      i. Chassis: 1756-A17
   2. Protocol Gateway:
      a. Model as required for native protocol to Ethernet/IP conversion for quantity of connected devices.
      b. DIN Rail mounted
   3. Manufacturers:
      a. All components shall be manufactured by Allen-Bradley or an Encompass Partner.

B. Operator Interface Terminal (OIT):
   1. Features:
      a. Touch screen flat display
      b. LED backlit LCD
      c. 24-bit 16.7M colors
      d. Size: 15” diagonal nominal, unless otherwise noted
      e. Resolution: 1024x768, minimum
      f. Communications: Ethernet/IP, USB
      g. SD card slot
      h. NEMA 12
      i. Real-time battery backed clock
      j. Memory: 1 GB RAM and 1 GB user storage
      k. Input Power: 120VAC
   2. Manufacturers:
      a. Allen-Bradley, PanelView 5510

2.2 SCHEDULES

A. Schedule: See attachment.

PART 3 - EXECUTION

3.1 CUSTOM PROGRAMMING

A. Custom Programming of all vendor provided control panels, including their PLCs and OITs, shall be provided by that vendor under the applicable specification section of the associated equipment.
   1. Provide database spreadsheets for peer-to-peer communication coordination between other onsite PLCs that need to share data.
   2. Provide database spreadsheets for Plant HMI/SCADA communication coordination.

3. Provide annotated copies of all PLC programs.
4. Provide an electronic copy of all PLC and OIT programming files for the Owner on a flash drive. Format shall be as required to reload into PLC memory. Logic version shall be the final program after all equipment has been installed and commissioned and Operational Demonstration is complete and successful to the Owner's approval.

B. Custom Programming of non-vendor provided control panels, including their PLCs and OITs, will be provided by the Owner.

C. Custom Programming of plant's existing HMI/SCADA will be provided by the Owner.

D. Variable Frequency Drives
1. Provide programming for all VFDs connected to the network.
2. Read and display the contents of a minimum of eight registers in each VFD.
3. Coordinate with the Owner prior to the start of programming to select the register to be displayed.

E. Graphic Screens
1. Submit all graphic screens for Owner review and comment when sixty percent complete.
2. Provide navigation controls on all screens to allow movement between screens.
3. Conform to NFPA 79, Industrial Machinery on colors for indicators and controls.
4. Conform to Owner standards for colors of process equipment and piping.
5. Utilize industry standard symbols or graphically realistic drawings for process equipment.
6. Provide a separate screen for each group of process equipment.
7. Group related screens in a logical manner such as by building, plant flow, liquid stream/solids stream, etc.
8. At a minimum, provide the following screens:
    a. Plant Overview
    b. NF Building Overview
    c. Break Tank Pumps Overview
    d. NF Feed Pumps Overview
    e. NF Skids Overview
    f. Corrosion Inhibitor System Overview
    g. Sodium Hydroxide System Overview
    h. Sodium Bisulfite System Overview
    i. Antiscalant System Overview
    j. Break Tank Pump Control Graphics
    k. NF Feed Pump Control Graphics
    l. Corrosion Inhibitor Chemical Equipment Control Graphics
    m. Corrosion Inhibitor Chemical Feed Control Graphic
    n. Sodium Hydroxide Chemical Equipment Control Graphics
    o. Sodium Hydroxide Chemical Feed Control Graphic
    p. Sodium Bisulfite Chemical Equipment Control Graphics
    q. Sodium Bisulfite Chemical Feed Control Graphic
    r. Antiscalant Chemical Equipment Control Graphics
    s. Antiscalant Chemical Feed Control Graphic
    t. Chemical Feed Building Overview
    u. Sodium Hypochlorite System Overview
    v. Fluoride System Overview
    w. Sodium Hypochlorite Chemical Equipment Control Graphics
    x. Sodium Hypochlorite Chemical Feed Control Graphic

y. Fluoride Chemical Equipment Control Graphics
z. Fluoride Chemical Feed Control Graphic
aa. Electrical Service Overview
bb. Alarm Summary Screens
cc. Equipment Runtimes (with resets) Screen
dd. Totalizers Screen
ee. (10) Analog Signal Trending Screens – Owner Directed
ff. (10) Overview/Control Screens – Owner Directed

F. Global Programmed Control Strategies
1. Meet with Plant Personnel before start of programming to determine:
a. Time of day for resetting of daily totalizers
b. Security Levels for all screens
c. The master PCS clock and approach to sync network devices
2. Display all alarms at the HMI.
3. Provide means to acknowledge all alarms at the HMI.
4. Provide alarms for PLC failure and network failure.
5. Totalize the number of starts for all process equipment and display on the plant HMI.
6. All process setpoints displayed on HMI screens and read back for confirmation.
7. All process setpoints adjustable from the HMI screens with correct security level.
8. Perform a runtime calculation for all process equipment at PLC and display at the HMI.
9. Display rate, total, and daily total for all process flows at the HMI.
10. Display all process levels at the HMI.
11. Store average daily flow rates and peak hourly flow rates of all flow meters one year or more at SCADA.
12. One year of data shall be stored for trending with data saved every 15 minutes. Daily totals shall also be saved. Each year, or at any time, the Operator shall be able to copy this data to a CD or DVD in a spreadsheet format.
13. All inline instrumentation shall be shown with instantaneous values on the HMI. One year of data shall be stored for trending. Each year, or at any time, the Operator shall be able to copy this data to a CD or DVD in a spreadsheet format.
14. All data shall be automatically graphed when chosen by the operator. These trending graphs shall not reset when closed or when the operator switches between data screens or other graphs.
15. All bits/elements in PLC logic shall be commented. If not used, then comment as SPARE.
16. SCADA historical graphs shall include programming to constantly refresh to appear as a “live, historical trend“.

G. SCADA Programming Funtional Requirements
1. The Functional Descriptions below are intended to aid in defining the scope of work for PLC/OIT/HMI programming. These functional descriptions are intended to be supplemental to the requirements as shown on the Drawings. Hardwired interlocks for equipment control may not be described below. Hardwired interlocks shall be mimicked in PLC logic.
2. Where the referenced detail applies to multiple, similar equipment controls, only one is described. Control for associated equipment is similar.
3. Reference the PLC I/O schedules. The PLC I/O shall be utilized by PLC/HMI programming, as required, to allow the respective equipment to function as described by the Contract Documents.

a. All alarm and equipment status monitoring PLC I/O inputted into the Plant Control System (PCS) shall be annunciated via the HMI.

4. All references to set points as "adjustable" below shall include the capability to adjust the set point via the HMI.

5. FUNCTIONAL DESCRIPTION INDEX:
   a. "6. NF BUILDING BREAK TANK"
   b. "7. NF BUILDING SOFTENING SYSTEM"
   c. "8. CORROSION INHIBITOR CHEMICAL FEED SYSTEM"
   d. "9. SODIUM HYDROXIDE CHEMICAL FEED SYSTEM"
   e. "10. SODIUM BISULFITE CHEMICAL FEED SYSTEM"
   f. "11. ANTISCALANT CHEMICAL FEED SYSTEM"
   g. "12. SODIUM HYPOCHLORITE CHEMICAL FEED SYSTEM"
   h. "13. FLUORIDE CHEMICAL FEED SYSTEM"
   i. "14. HIGH SERVICE PUMPS"
   j. "15. EXISTING PROCESS CONTROL MODIFICATIONS"
   k. "16. EMERGENCY POWER"
   l. "17. CRITICAL ALARMS"

6. NF BUILDING BREAK TANK
   a. Break Tank 1 Level
      1) General: Used to continuously monitor the liquid level in the Break Tank.
      2) Control:
         a) Local: None
         b) PCS: None
      3) Logic Interlocks/Permissives:
         a) Used for control of existing groundwater wells.
      4) Monitoring:
         a) Local: Instantaneous level indication
         b) PCS: Break Tank 1 Level
      5) Alarms:
         a) Local: None
         b) PCS: High-High, High, Low, Low-Low Break Tank 1 Level, Loss of Signal
   b. Break Tank 1 Low Cutoff Level
      1) General: Used to protect the Break Tank Pumps from operating when level is too low.
      2) Control:
         a) Local: None
         b) PCS: None
      3) Logic Interlocks/Permissives:
         a) None
      4) Monitoring:
         a) Local: None
         b) PCS: None
      5) Alarms:
         a) Local: None
         b) PCS: Break Tank 1 Low Level

7. NF BUILDING SOFTENING SYSTEM
   a. Break Tank Pump 1

1) General: Used to source water from the Break Tank to the NF Building process (softening and/or bypass).
2) Control:
    a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
    b) VFD: The VFD frequency can be manually adjusted utilizing the potentiometer or VFD HIM module at the VFD.
    c) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of Break Tank Pump 1 via the HMI.
        (1) PC MANUAL: The operator shall have the ability to manually start/stop and adjust the frequency of Break Tank Pump 1.
        (2) AUTO: Break Tank Pump 1 shall be automatically controlled via PLC programming. Break Tank Pump 1 speed shall be varied maintain an operator entered NF Feed Pump Suction Header Pressure setpoint. Break Tank Pumps shall be assigned a Lead, Lag 1, Lag 2, or Standby role and start/stop as needed to meet the setpoint.
3) Logic Interlocks/Permissives:
    a) NF Bypass Valve must not be closed for the pump to operate.
4) Monitoring:
    a) Local: Running, Stopped
    b) VFD: Running, Stopped, Frequency, Amps, Volts
    c) PCS: Remote, Running, Stopped, Frequency, Amps, Volts, VFD LOR Switch Position
5) Alarms:
    a) Local: General Alarm
    b) VFD: VFD Fault Alarm
    c) PCS: Motor High Temperature, High Discharge Pressure, VFD Fault, Loss of Signal

b. Break Tank Pump 1 Discharge Pressure
1) General: Used to continuously monitor the discharge pressure for Break Tank Pump 1.
2) Control:
    a) Local: None
    b) PCS: None
3) Logic Interlocks/Permissives:
    a) None
4) Monitoring:
    a) Local: Instantaneous pressure indication
    b) PCS: Break Tank Pump 1 Discharge Pressure
5) Alarms:
    a) Local: None
    b) PCS: High-High, High, Low, Low-Low Break Tank Pump 1 Discharge Pressure, Loss of Signal

c. NF Bypass Flow
1) General: Used to continuously monitor the NF Bypass flow rate.
2) Control:

a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) Reference the NF Bypass Flow Control Loop

4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: NF Bypass Flow

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Bypass Flow, Loss of Signal

d. NF Bypass Flow Control Valve

1) General: Used to divert flow around the membrane skids.

2) Control:
a) Local: With the LOCAL-STOP-REMOTE selector switch at the actuator in the LOCAL position, the operator can open or close the valve by using the OPEN-CLOSE selector switch at the actuator. With the LOCAL-STOP-REMOTE selector switch at the actuator in the STOP position, the actuator will stop and maintain its current position.
b) PCS: With the LOCAL-STOP-REMOTE selector switch at the actuator in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the NF Bypass Flow Control Valve via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually set a desired position.
(2) AUTO: The NF Bypass Flow Control Valve shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED, HARDNESS, and PERCENT control modes.
(a) FIXED: The valve position shall vary in order to maintain an operator entered desired NF Bypass Flow rate.
(b) HARDNESS: The valve position shall vary in order to maintain an operator entered desired Blended Water Hardness.
a. If no Break Tank Pumps are operating and a plant run command is active, the valve shall move to the operator entered plant startup initial position and shall remain at that position until a Break Tank Pump starts operating.
b. Flow rate = [(BW flowrate x BW hardness) – (NFP flowrate x NFP hardness)] / NFF hardness
(c) PERCENT: The valve position shall vary in order to maintain an operator entered desired NF Bypass Flow rate as a percentage of Blended Water Flow.
a. If no Break Tank Pumps are operating and a plant run command is active, the valve shall move to the operator entered plant startup

initial position and shall remain at that position until a Break Tank Pump starts operating.

3) Logic Interlocks/Permissives: None
4) Monitoring:
   a) Local: Opened, Closed, Position
   b) PCS: Remote, Opened, Closed, Position
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal

e. Break Tank Pumps Discharge Header Pressure
1) General: Used to continuously monitor the pressure for Break Tank Pump Discharge Header.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous pressure indication
   b) PCS: Break Tank Pumps Discharge Header Pressure
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Break Tank Pumps Header Discharge Pressure, Loss of Signal

f. Cartridge Filter 1 Differential Pressure
1) General: Used to monitor if the Cartridge Filter needs cleaned.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous differential pressure indication
   b) PCS: Cartridge Filter 1 Differential Pressure
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Cartridge Filter 1 Differential Pressure, Loss of Signal

g. NF Feed ORP (Pre-Injection) Level
1) General: Used to continuously monitor the ORP level of the NF Feed water prior to chemical injection.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Used for chemical feed dosing calculations.
4) Monitoring:
   a) Local: Instantaneous ORP level indication
   b) PCS: NF Feed ORP (Pre-Injection) Level
5) Alarms:

a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed ORP (Pre-Injection) Level, Loss of Signal

h. NF Feed Pumps Suction Header Pressure
1) General: Used to continuously monitor the pressure for NF Feed Pumps Suction Header.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Used for Break Tank Pump speed control.
4) Monitoring:
a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pumps Suction Header Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pumps Suction Header Pressure, Loss of Signal

i. NF Feed ORP (Post-Injection) Level
1) General: Used to continuously monitor the ORP level of the NF Feed water after chemical injection.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous ORP level indication
b) PCS: NF Feed ORP (Post-Injection) Level
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed ORP (Post-Injection) Level, Loss of Signal

j. NF Feed Pump 1 Suction Pressure
1) General: Used to continuously monitor the pressure for NF Feed Pump 1 Suction.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pump 1 Suction Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pump 1 Suction Pressure, Loss of Signal

k. NF Feed Pump 1
1) General: Used to source water to the membrane skids.
2) Control:

a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) VFD: The VFD frequency can be manually adjusted utilizing the potentiometer or VFD HIM module at the VFD.
c) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of NF Feed Pump 1 via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop and adjust the frequency of NF Feed Pump 1.
(2) AUTO: NF Feed Pump 1 shall be automatically controlled via PLC programming. NF Feed Pump 1 speed shall be varied as called for by the NF Skids Master PLC.

3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: Running, Stopped
b) VFD: Running, Stopped, Frequency, Amps, Volts
c) PCS: Remote, Running, Stopped, (2) Vibration Sensors, (2) Motor Bearing Temps, Frequency, Amps, Volts, VFD LOR Switch Position
5) Alarms:
a) Local: General Alarm
b) VFD: VFD Fault Alarm
c) PCS: Motor High Temperature, (2) High Vibration Alarms, (2) High Bearing Temp Alarm, Low Suction Pressure, High Discharge Pressure, VFD Fault, Loss of Signal

l. NF Feed Pump 1 Discharge Pressure
1) General: Used to continuously monitor the pressure for NF Feed Pump 1 Discharge.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous pressure indication
b) PCS: NF Feed Pump 1 Discharge Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low NF Feed Pump 1 Discharge Pressure, Loss of Signal

m. Degasifier 1
1) General: Used to remove gases from the water before entering the clearwell.
2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the blower via the START/STOP pushbuttons.

b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of Degasifier 1 via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop Degasifier 1.
(2) AUTO: Degasifier 1 shall be automatically controlled via PLC programming. Degasifier 1 shall operate whenever the plant is running.

3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote
5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

n. Degasifier 1 Inlet Screen Differential Pressure
1) General: Used to monitor if Degasifier 1 Screen needs cleaned.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous differential pressure indication
b) PCS: Degasifier 1 Screen Differential Pressure
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Degasifier 1 Inlet Screen Differential Pressure, Loss of Signal

o. Blended Water Flow
1) General: Used to continuously monitor the Blended Water flow rate.
2) Control:
a) Local: None
b) PCS: Operator shall have the ability to select MAINTENANCE, FLOWMETER, or SUM TOTAL as the BW Flow signal source via the HMI.
(1) MAINTENANCE: The operator shall have the ability to enter in a flow value during flowmeter maintenance to reduce impact on chemical feed systems.
(2) FLOWMETER: The signal from this flowmeter is used.
(3) SUM TOTAL: The sum of all Skid Discharge Flows plus the NF Bypass Flow signal is used.
3) Logic Interlocks/Permissives:
a) Used for the chemical feed dosing calculations.
4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: Blended Water Flow
5) Alarms:
a) Local: None

b) PCS: High-High, High, Low, Low-Low Blended Water Flow, Loss of Signal

p. Blended Water pH
1) General: Used to continuously monitor the pH level of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Used for chemical feed dosing calculations.
4) Monitoring:
a) Local: Instantaneous pH indication
b) PCS: Blended Water pH
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water pH, Loss of Signal

q. Blended Water Chlorine Residual
1) General: Used to continuously monitor the chlorine residual of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous Chlorine Residual indication
b) PCS: Blended Water Chlorine Residual
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Chlorine Residual, Loss of Signal

r. Blended Water Fluoride Residual
1) General: Used to continuously monitor the fluoride residual of the Blended Water.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous Fluoride Residual indication
b) PCS: Blended Water Fluoride Residual
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Blended Water Fluoride Residual, Loss of Signal

s. Blended Water Phosphate Residual
1) General: Used to continuously monitor the phosphate residual of the Blended Water.
2) Control:
a) Local: None

b) PCS: None

3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous Phosphate Residual indication
   b) PCS: Blended Water Phosphate Residual
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Blended Water Phosphate Residual, Loss of Signal

t. NF Concentrate Conductivity
1) General: Used to continuously monitor the conductivity of the skid concentrate.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous conductivity indication
   b) PCS: NF Concentrate Conductivity
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low NF Concentrate Conductivity, Loss of Signal

u. NF Concentrate pH
1) General: Used to continuously monitor the pH level of the NF Concentrate.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous pH indication
   b) PCS: NF Concentrate pH
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low NF Concentrate pH, Loss of Signal

v. NF Skid Control Interface
1) General: All control of individual NF Skids, Membrane Cleaning System, and associated equipment is performed by the NF Skids Master PLC. Custom programming requirements for that vendored system are specified under Section 466340. Programming requirements described below are provided under this Section for NF Building ACP PLC/OIT and SCADA.
2) Operator shall have the ability to enter the following water quality parameters for NF Feed and NF Permeate. These values will be used to determine the NF Bypass flowrate when operated in HARDNESS mode.
   a) Total Hardness in NF Feed (THNFF = 366 mg/L as $CaCO_3$
   b) Total Hardness in NF Permeate (THNFP = 10.8 mg/L as $CaCO_3$
3) PLC shall calculate and SCADA shall indicate and trend the following:

a) Total NF Feed flow rate (Total NFF = NFP + NFC)
b) NF Bypass Flow (NFB = NFP x %NFB).
c) Indicate Raw Water Flow Rate (RW = NFF + NFB).
d) Actual %NFB (%NFB = NFB / BLW)
(1) NFB from flow meter
(2) BLW = NFP flow meters from skids + NFB flow meter
(3) THBLW = [(NFB x THNFF) + (NFP x THNFP)] / BW

4) All Skid OIT and MCS screen information and operator entry shall be duplicated at SCADA.

w. NF Process Start/Stop

1) Control: Operator shall have the ability to place the softening process on automated Start/Stop control. If enabled, the plant shall start if the existing clearwell level drops below an operator adjustable setpoint. The plant shall shutdown if the clearwell level rises above an operator adjustable setpoint. Operator shall have the ability to select which clearwell level to use as the primary control signal.

2) When the plant startup is auto initiated:
a) Open NF Bypass Valve to initial setpoint.
b) Start Chemical Feed Systems.
c) Start Break Tank Pump.
d) Start UV System.
e) Start NF Feed Pumps and NF Skids (in multiples of two). The quantity of skids needed shall be based on NF Skid Call Level setpoints.

3) When the plant shutdown is auto initiated:
a) NF Skids and NF Feed Pumps shall perform a permeate flush or forward flush before stopping.
b) Break Tank Pumps shall continue to operate until all NF Skids and NF Feed Pumps have stopped.
c) Stop UV System.
d) Close NF Bypass Valve.
e) Stop Chemical Feed Systems.

8. CORROSION INHIBITOR CHEMICAL FEED SYSTEM

a. Corrosion Inhibitor Storage Tank 1 Level

1) General: Used to continuously monitor the liquid level in Corrosion Inhibitor Storage Tank 1.

2) Control:
a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Instantaneous level indication
b) PCS: Corrosion Inhibitor Storage Tank 1 Level

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Corrosion Inhibitor Storage Tank 1 Level, Loss of Signal

b. Corrosion Inhibitor Storage Tank 1 Outlet Valve

1) General: Used to isolate Corrosion Inhibitor Storage Tank 1 from the outlet header.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (4) PC MANUAL: The operator shall have the ability to open or close the valve.
      (5) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

c. Corrosion Inhibitor Storage Tank 1 Recirc Valve
1) General: Used to direct chemical to Corrosion Inhibitor Storage Tank 1 from the transfer pump.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

d. Corrosion Inhibitor Transfer Pump
1) General: Used to pump Corrosion Inhibitor chemical between tanks.
2) Control:

a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Corrosion Inhibitor Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Corrosion Inhibitor Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

e. Corrosion Inhibitor Day Tank Inlet Valve

1) General: Used to direct chemical to Corrosion Inhibitor Day Tank from the transfer pump.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Corrosion Inhibitor Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

f. Corrosion Inhibitor Day Tank High Level

1) General: Used to prevent overfilling the day tank.

2) Control:
a) Local: None.
b) PCS: None.

3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Corrosion Inhibitor Day Tank High Level

g. Corrosion Inhibitor Day Tank Weight
1) General: Used to continuously monitor the weight of the Corrosion Inhibitor Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Corrosion Inhibitor Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Corrosion Inhibitor Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Corrosion Inhibitor Day Tank Weight, Loss of Signal

h. Corrosion Inhibitor Feed Pump 1
1) General: Used to inject Corrosion Inhibitor into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
      (2) AUTO: Corrosion Inhibitor Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
         (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
         (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint.
3) Logic Interlocks/Permissives:
   a) Corrosion Inhibitor Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:

a) Local: Fault
b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Corrosion Inhibitor Chemical Transfer Sequence
1) General: Used for automated control of transferring chemical between tanks.
2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
(1) TRANSFER:
a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.
(2) RECIRC:
a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Corrosion Inhibitor Feed Room Emergency Eyewash/Shower Flow Switch
1) General: Used to detect an activation of the emergency eyewash/shower.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Corrosion Inhibitor Feed Room Emergency Eyewash/Shower Activated

k. Corrosion Inhibitor Containment Area Wet Floor Switch
1) General: Used to detect a Corrosion Inhibitor tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Corrosion Inhibitor Containment Area Wet Floor Switch Activated

9. SODIUM HYDROXIDE CHEMICAL FEED SYSTEM

a. Sodium Hydroxide Storage Tank 1 Level
   1) General: Used to continuously monitor the liquid level in Sodium Hydroxide Storage Tank 1.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Instantaneous level indication
      b) PCS: Sodium Hydroxide Storage Tank 1 Level
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Storage Tank 1 Level, Loss of Signal

b. Sodium Hydroxide Storage Tank 1 Outlet Valve
   1) General: Used to isolate Sodium Hydroxide Storage Tank 1 from the outlet header.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None
      b) PCS: None

c. Sodium Hydroxide Storage Tank 1 Recirc Valve
   1) General: Used to direct chemical to Sodium Hydroxide Storage Tank 1 from the transfer pump.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.

(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hydroxide Chemical Transfer Sequence

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Sodium Hydroxide Transfer Pump

1) General: Used to pump Sodium Hydroxide chemical between tanks.

2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Sodium Hydroxide Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hydroxide Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

e. Sodium Hydroxide Day Tank Inlet Valve

1) General: Used to direct chemical to Sodium Hydroxide Day Tank from the transfer pump.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.

(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hydroxide Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

f. Sodium Hydroxide Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
   a) Local: None.
   b) PCS: None.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Sodium Hydroxide Day Tank High Level

g. Sodium Hydroxide Day Tank Weight
1) General: Used to continuously monitor the weight of the Sodium Hydroxide Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hydroxide Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Sodium Hydroxide Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Day Tank Weight, Loss of Signal

h. Sodium Hydroxide Feed Pump 1
1) General: Used to inject Sodium Hydroxide into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.

(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Hydroxide Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired Blended Water pH setpoint.

3) Logic Interlocks/Permissives:
a) Sodium Hydroxide Day Tank Low-Low Level Alarm must be inactive for pump to operate.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Fault
b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Sodium Hydroxide Carrier Water Valve

1) General: Used to convey chemical for injection into the process stream.

2) Control:
a) Local: None
b) PCS: The operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall be open when any Sodium Hydroxide Feed Pump is operating.

3) Logic Interlocks/Permissives:
a) None

4) Monitoring:
a) Local: None
b) PCS: Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

j. Sodium Hydroxide Chemical Transfer Sequence

1) General: Used for automated control of transferring chemical between tanks.

2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
(1) TRANSFER:
a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.

b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.

h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

k. Sodium Hydroxide Feed Room Emergency Eyewash/Shower Flow Switch
1) General: Used to detect an activation of the emergency eyewash/shower.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hydroxide Feed Room Emergency Eyewash/Shower Activated

l. Sodium Hydroxide Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Hydroxide tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hydroxide Containment Area Wet Floor Switch Activated

m. Sodium Hydroxide Feed Room Temperature
1) General: Used to continuously monitor the temperature of the Sodium Hydroxide Feed Room.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous temperature indication
b) PCS: Sodium Hydroxide Feed Room Temperature
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hydroxide Feed Room Temperature, Loss of Signal

10. SODIUM BISULFITE CHEMICAL FEED SYSTEM

a. Sodium Bisulfite Storage Tank 1 Level
   1) General: Used to continuously monitor the liquid level in Sodium Bisulfite Storage Tank 1.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Instantaneous level indication
      b) PCS: Sodium Bisulfite Storage Tank 1 Level
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low Sodium Bisulfite Storage Tank 1 Level, Loss of Signal

b. Sodium Bisulfite Storage Tank 1 Outlet Valve
   1) General: Used to isolate Sodium Bisulfite Storage Tank 1 from the outlet header.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Bisulfite Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None
      b) PCS: None

c. Sodium Bisulfite Storage Tank 1 Recirc Valve
   1) General: Used to direct chemical to Sodium Bisulfite Storage Tank 1 from the transfer pump.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.

(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Bisulfite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Bisulfite Chemical Transfer Sequence

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Sodium Bisulfite Transfer Pump

1) General: Used to pump Sodium Bisulfite chemical between tanks.

2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Sodium Bisulfite Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Sodium Bisulfite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Bisulfite Chemical Transfer Sequence.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

e. Sodium Bisulfite Day Tank Inlet Valve

1) General: Used to direct chemical to Sodium Bisulfite Day Tank from the transfer pump.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.

(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Bisulfite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
   a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

f. Sodium Bisulfite Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
   a) Local: None.
   b) PCS: None.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Sodium Bisulfite Day Tank High Level

g. Sodium Bisulfite Day Tank Weight
1) General: Used to continuously monitor the weight of the Sodium Bisulfite Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Bisulfite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Sodium Bisulfite Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Bisulfite Day Tank Weight, Loss of Signal

h. Sodium Bisulfite Feed Pump 1
1) General: Used to inject Sodium Bisulfite into the water for treatment.
2) Control:
   a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
   b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.

(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Bisulfite Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired NF Feed ORP (Pre-Injection) setpoint.

3) Logic Interlocks/Permissives:
a) Sodium Bisulfite Day Tank Low-Low Level Alarm must be inactive for pump to operate.

4) Monitoring:
a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Fault
b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Sodium Bisulfite Chemical Transfer Sequence

1) General: Used for automated control of transferring chemical between tanks.

2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
(1) TRANSFER:
a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.
(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Sodium Bisulfite Feed Room Emergency Eyewash/Shower Flow Switch

1) General: Used to detect an activation of the emergency eyewash/shower.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None

b) PCS: Sodium Bisulfite Feed Room Emergency Eyewash/Shower Activated

k. Sodium Bisulfite Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Bisulfite tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Bisulfite Containment Area Wet Floor Switch Activated

l. Sodium Bisulfite Feed Room Temperature
1) General: Used to continuously monitor the temperature of the Sodium Bisulfite Feed Room.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) None
4) Monitoring:
a) Local: Instantaneous temperature indication
b) PCS: Sodium Bisulfite Feed Room Temperature
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Bisulfite Feed Room Temperature, Loss of Signal

11. ANTISCALANT CHEMICAL FEED SYSTEM
a. Antiscalant Transfer Pump
1) General: Used to pump Antiscalant chemical between tanks.
2) Control:
a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
(2) AUTO: Antiscalant Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Antiscalant Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
a) Reference the Antiscalant Chemical Transfer Sequence.
4) Monitoring:

a) Local: Running, Stopped
b) PCS: Running, Stopped, Remote

5) Alarms:
a) Local: Alarm
b) PCS: Motor High Temperature, Motor Overload

b. Antiscalant Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
a) Local: None.
b) PCS: None.
3) Logic Interlocks/Permissives:
a) Reference the Antiscalant Chemical Transfer Sequence.
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Antiscalant Day Tank High Level

c. Antiscalant Day Tank Weight
1) General: Used to continuously monitor the weight of the Antiscalant Day Tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Antiscalant Chemical Transfer Sequence.
4) Monitoring:
a) Local: Instantaneous weight indication
b) PCS: Antiscalant Day Tank Weight
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Antiscalant Day Tank Weight, Loss of Signal

d. Antiscalant Feed Pump 1
1) General: Used to inject Antiscalant into the water for treatment.
2) Control:
a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Bisulfite Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.

(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint using the sum of all Skid Inlet Flows.

3) Logic Interlocks/Permissives:
   a) Antiscalant Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

e. Antiscalant Injection Flow
   1) General: Used to detect that Antiscalant is being injected into the process stream.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) An Antiscalant Feed Pump must be operating for alarm logic to be active.
      b) Antiscalant flow must be present for an NF Skid to operate.
   4) Monitoring:
      a) Local: None
      b) PCS: None
   5) Alarms:
      a) Local: None
      b) PCS: Antiscalant No Flow Alarm

f. Antiscalant Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
      b) PCS: The operator shall be able to fill the day tank automatically using PLC programming.
         (1) DAY TANK FILL:
            a. The operator shall select the source storage tank and enter a Stop weight setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the transfer pump shall operate until the Stop weight is reached.
            d. Once the weight is reached, the transfer pump shall stop.
            e. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
            f. Day Tank High Level Alarm must be inactive for the transfer pump to start.
            g. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.

h. All applicable equipment must not have any active alarms in order to initiate the transfer.

12. SODIUM HYPOCHLORITE CHEMICAL FEED SYSTEM
    a. Sodium Hypochlorite Storage Tank 1 Level
        1) General: Used to continuously monitor the liquid level in Sodium Hypochlorite Storage Tank 1.
        2) Control:
            a) Local: None
            b) PCS: None
        3) Logic Interlocks/Permissives:
            a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
        4) Monitoring:
            a) Local: Instantaneous level indication
            b) PCS: Sodium Hypochlorite Storage Tank 1 Level
        5) Alarms:
            a) Local: None
            b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Storage Tank 1 Level, Loss of Signal
    b. Sodium Hypochlorite Storage Tank 1 Outlet Valve
        1) General: Used to isolate Sodium Hypochlorite Storage Tank 1 from the outlet header.
        2) Control:
            a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
            b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
                (3) PC MANUAL: The operator shall have the ability to open or close the valve.
                (4) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.
        3) Logic Interlocks/Permissives:
            a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
        4) Monitoring:
            a) Local: Opened, Closed
            b) PCS: Remote, Opened, Closed
        5) Alarms:
            a) Local: None
            b) PCS: None
    c. Sodium Hypochlorite Storage Tank 1 Recirc Valve
        1) General: Used to direct chemical to Sodium Hypochlorite Storage Tank 1 from the transfer pump.
        2) Control:
            a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.

b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence

4) Monitoring:
a) Local: Opened, Closed
b) PCS: Remote, Opened, Closed

5) Alarms:
a) Local: None
b) PCS: None

d. Sodium Hypochlorite Dilution Water Flow

1) General: Used to continuously monitor the Sodium Hypochlorite Dilution Water flow rate.

2) Control:
a) Local: None
b) PCS: None

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Dilution Control Loop.

4) Monitoring:
a) Local: Instantaneous flow indication
b) PCS: Sodium Hypochlorite Dilution Water Flow

5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Dilution Water Flow, Loss of Signal

e. Sodium Hypochlorite Storage Tank 1 Dilution Water Valve

1) General: Used to direct dilution water to Sodium Hypochlorite Storage Tank 1 to lower the solution concentration.

2) Control:
a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
(1) PC MANUAL: The operator shall have the ability to open or close the valve.
(2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Dilution Control Loop.

3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Dilution Control Loop.

4) Monitoring:
a) Local: Opened, Closed

b) PCS: Remote, Opened, Closed

5) Alarms:
   a) Local: None
   b) PCS: None

f. Sodium Hypochlorite Transfer Pump
1) General: Used to pump Sodium Hypochlorite chemical between tanks.
2) Control:
   a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
   b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
      (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
      (2) AUTO: Sodium Hypochlorite Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Sodium Hypochlorite Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Alarm
   b) PCS: Motor High Temperature, Motor Overload

g. Sodium Hypochlorite Day Tank Inlet Valve
1) General: Used to direct chemical to Sodium Hypochlorite Day Tank from the transfer pump.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Sodium Hypochlorite Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:

a) Local: None
b) PCS: None

h. Sodium Hypochlorite Day Tank Level
1) General: Used to continuously monitor the liquid level in Sodium Hypochlorite Day Tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
a) Local: Instantaneous level indication
b) PCS: Sodium Hypochlorite Day Tank Level
5) Alarms:
a) Local: None
b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Day Tank Level, Loss of Signal

i. Sodium Hypochlorite Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives:
a) Reference the Sodium Hypochlorite Chemical Transfer Sequence.
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hypochlorite Day Tank High Level

j. Sodium Hypochlorite Disinfection Feed Pump 1
1) General: Used to inject Sodium Hypochlorite into the water for disinfection treatment.
2) Control:
a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
(1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
(2) AUTO: Sodium Hypochlorite Disinfection Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
(a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.

(b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Blended Water Flow.

3) Logic Interlocks/Permissives:
   a) Sodium Hypochlorite Day Tank Low-Low Level Alarm must be inactive for pump to operate.
4) Monitoring:
   a) Local: Running, Stopped
   b) PCS: Running, Stopped, Remote
5) Alarms:
   a) Local: Fault
   b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

k. Sodium Hypochlorite Oxidation Feed Pump 1
   1) General: Used to inject Sodium Hypochlorite into the water for oxidation treatment.
   2) Control:
      a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
      b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
         (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
         (2) AUTO: Sodium Hypochlorite Oxidation Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
            (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
            (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Total Filter Flow.
   3) Logic Interlocks/Permissives:
      a) Sodium Hypochlorite Day Tank Low-Low Level Alarm must be inactive for pump to operate.
   4) Monitoring:
      a) Local: Opened, Closed, Position
      b) PCS: Remote, Opened, Closed, Position
   5) Alarms:
      a) Local: Fault
      b) PCS: Fault, Loss of Signal

l. Sodium Hypochlorite Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.

b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.

(1) TRANSFER:

a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop level setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.

d. Once both opened, the transfer pump shall operate until the Stop level is reached.
e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Level Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Switch Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

m. Sodium Hypochlorite Dilution Control Loop
1) General: Used for automated control of adding dilution water to storage tanks to reduce the concentration of the solution.
2) Control:
a) Local: The operator shall have the ability at the LCP to manually operate system equipment to add dilution water.
b) PCS: The operator shall be able to add dilution water automatically using PLC programming.
(1) Dilution Water Sequence:
a. The operator shall select which storage tanks to add dilution water to and enter a GALLONS setpoint.
b. The applicable Storage Tank Dilution Water Valves will open.
c. Once the GALLONS setpoint has been reached, the valves shall close.
d. Applicable Storage Tank(s) High Level Alarm(s) must be inactive for the sequence to start.
e. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
f. All applicable equipment must not have any active alarms in order to initiate the sequence.

n. Sodium Hypochlorite Containment Area Wet Floor Switch
1) General: Used to detect a Sodium Hypochlorite tank leak.
2) Control:
a) Local: None
b) PCS: None
3) Logic Interlocks/Permissives: None
4) Monitoring:
a) Local: None
b) PCS: None
5) Alarms:
a) Local: None
b) PCS: Sodium Hypochlorite Containment Area Wet Floor Switch Activated

o. Sodium Hypochlorite Feed Room Temperature
1) General: Used to continuously monitor the temperature of the Sodium Hypochlorite Feed Room.

2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) None
4) Monitoring:
   a) Local: Instantaneous temperature indication
   b) PCS: Sodium Hypochlorite Feed Room Temperature
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Sodium Hypochlorite Feed Room Temperature, Loss of Signal

13. FLUORIDE CHEMICAL FEED SYSTEM

a. Fluoride Storage Tank 1 Level
   1) General: Used to continuously monitor the liquid level in Fluoride Storage Tank 1.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Instantaneous level indication
      b) PCS: Fluoride Storage Tank 1 Level
   5) Alarms:
      a) Local: None
      b) PCS: High-High, High, Low, Low-Low Fluoride Storage Tank 1 Level, Loss of Signal

b. Fluoride Storage Tank 1 Outlet Valve
   1) General: Used to isolate Fluoride Storage Tank 1 from the outlet header.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None

b) PCS: None

c. Fluoride Storage Tank 1 Recirc Valve
   1) General: Used to direct chemical to Fluoride Storage Tank 1 from the transfer pump.
   2) Control:
      a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
      b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
         (1) PC MANUAL: The operator shall have the ability to open or close the valve.
         (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence
   4) Monitoring:
      a) Local: Opened, Closed
      b) PCS: Remote, Opened, Closed
   5) Alarms:
      a) Local: None
      b) PCS: None

d. Fluoride Transfer Pump
   1) General: Used to pump Fluoride chemical between tanks.
   2) Control:
      a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
      b) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI.
         (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump.
         (2) AUTO: Fluoride Transfer Pump shall be automatically controlled via PLC programming. The pump shall operate as called for by the Fluoride Chemical Transfer Sequence.
   3) Logic Interlocks/Permissives:
      a) Reference the Fluoride Chemical Transfer Sequence.
   4) Monitoring:
      a) Local: Running, Stopped
      b) PCS: Running, Stopped, Remote
   5) Alarms:
      a) Local: Alarm
      b) PCS: Motor High Temperature, Motor Overload

e. Fluoride Day Tank Inlet Valve

1) General: Used to direct chemical to Fluoride Day Tank from the transfer pump.
2) Control:
   a) Local: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the OPEN position, the actuator shall open. With the OPEN-REMOTE-CLOSE selector switch at the LCP in the CLOSE position, the actuator shall close.
   b) PCS: With the OPEN-REMOTE-CLOSE selector switch at the LCP in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the actuator via the HMI.
      (1) PC MANUAL: The operator shall have the ability to open or close the valve.
      (2) AUTO: The valve shall be automatically controlled via PLC programming. The valve shall open and close as called for by the Fluoride Chemical Transfer Sequence.
3) Logic Interlocks/Permissives:
   a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Opened, Closed
   b) PCS: Remote, Opened, Closed
5) Alarms:
   a) Local: None
   b) PCS: None

f. Fluoride Day Tank High Level
1) General: Used to prevent overfilling the day tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
   a) Local: None
   b) PCS: None
5) Alarms:
   a) Local: None
   b) PCS: Fluoride Day Tank High Level

g. Fluoride Day Tank Weight
1) General: Used to continuously monitor the weight of the Fluoride Day Tank.
2) Control:
   a) Local: None
   b) PCS: None
3) Logic Interlocks/Permissives:
   a) Reference the Fluoride Chemical Transfer Sequence.
4) Monitoring:
   a) Local: Instantaneous weight indication
   b) PCS: Fluoride Day Tank Weight
5) Alarms:
   a) Local: None
   b) PCS: High-High, High, Low, Low-Low Fluoride Day Tank Weight, Loss of Signal

h. Fluoride Feed Pump 1
   1) General: Used to inject Fluoride into the water for treatment.
   2) Control:
      a) Local: With the LOCAL-REMOTE selector switch at the pump in the LOCAL position, the operator can operate the pump per the manufacturer's interface.
      b) PCS: With the LOCAL-REMOTE selector switch at the pump in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of the pump via the HMI. Operator shall have the ability to enter the solution concentration, specific gravity, and pump capacity.
         (1) PC MANUAL: The operator shall have the ability to manually start/stop the pump and set a desired speed.
         (2) AUTO: Fluoride Feed Pump 1 shall be automatically controlled via PLC programming. Operators shall have the ability to select between FIXED and DOSE control modes.
            (a) FIXED: The pump speed shall maintain an operator entered desired lbs/day setpoint.
            (b) DOSE: The pump speed shall vary in order to maintain an operator entered desired mg/L setpoint while using Blended Water Flow.
   3) Logic Interlocks/Permissives:
      a) Fluoride Day Tank Low-Low Level Alarm must be inactive for pump to operate.
   4) Monitoring:
      a) Local: Running, Stopped
      b) PCS: Running, Stopped, Remote
   5) Alarms:
      a) Local: Fault
      b) PCS: Fault, Loss of Signal, Flow Deviation Alarm

i. Fluoride Chemical Transfer Sequence
   1) General: Used for automated control of transferring chemical between tanks.
   2) Control:
      a) Local: The operator shall have the ability at the LCP to manually operate system equipment to transfer chemical.
      b) PCS: The chemical transfer sequence shall automatically enable the piping path and start/stop and open/close devices as configured by an operator via the HMI. The operator shall choose the desired function by pressing the TRANSFER, RECIRC, or DAY TANK FILL pushbuttons on the HMI.
         (1) TRANSFER:
            a. The operator shall select the source Storage Tank, destination Storage Tank, and enter a Stop level setpoint.
            b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
            c. Once the button is pressed, the source tank outlet valve and destination tank recirc valve shall open.
            d. Once both opened, the transfer pump shall operate until the Stop level is reached.

e. Once the level is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The source storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. The destination storage tank High Level Alarm must be inactive for the transfer pump to start.
i. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
j. All applicable equipment must not have any active alarms in order to initiate the transfer.

(2) RECIRC:

a. The operator shall select a storage tank and enter a desired time duration setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet and recirc valves shall open.
d. Once both opened, the transfer pump shall operate until the time duration has expired.
e. Once time expires, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the sequence.
i. All applicable equipment must not have any active alarms in order to initiate the sequence.

(3) DAY TANK FILL:

a. The operator shall select the source storage tank and enter a Stop weight setpoint.
b. The operator shall initiate the sequence by pressing the INITIATE TRANSFER pushbutton on the local control panel.
c. Once the button is pressed, the storage tank outlet valve and day tank inlet valve shall open.
d. Once both opened, the transfer pump shall operate until the Stop weight is reached.
e. Once the weight is reached, both valves shall travel closed.
f. Once either valve is closed, the transfer pump shall stop.
g. The storage tank Low-Low Level Alarm must be inactive for the transfer pump to start.
h. Day Tank High Weight Alarm must be inactive for the transfer pump to start.
i. Day Tank High Level Alarm must be inactive for the transfer pump to start.
j. All applicable equipment must be in REMOTE-AUTO mode in order to initiate the transfer.
k. All applicable equipment must not have any active alarms in order to initiate the transfer.

j. Fluoride Containment Area Wet Floor Switch
   1) General: Used to detect a Fluoride tank leak.
   2) Control:
      a) Local: None
      b) PCS: None
   3) Logic Interlocks/Permissives: None
   4) Monitoring:
      a) Local: None
      b) PCS: None
   5) Alarms:
      a) Local: None
      b) PCS: Fluoride Containment Area Wet Floor Switch Activated

14. HIGH SERVICE PUMPS
   a. High Service Pump 5
      1) General: Used to pump water into the water distribution system.
      2) Control:
         a) Local: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the LOCAL position, the operator shall have the ability to START and STOP the pump via the START/STOP pushbuttons.
         b) VFD: The VFD speed can be manually adjusted utilizing the manual speed potentiometer or VFD HIM module at the VFD.
         c) PCS: With the LOCAL-OFF-REMOTE selector switch at the local control panel in the REMOTE position, the operator shall have the ability to select PC MANUAL or AUTO control of High Service Pump 5 via the HMI.
            (1) PC MANUAL: The operator shall have the ability to manually start/stop and adjust the speed of High Service Pump 5.
            (2) AUTO: High Service Pump 5 shall be automatically controlled via PLC programming. High Service Pump 5 shall be incorporated into the existing High Service Pump control scheme.
      3) Logic Interlocks/Permissives: None
      4) Monitoring:
         a) Local: Running, Stopped
         b) VFD: Running, Stopped, Frequency, Amps, Volts
         c) PCS: Remote, Running, Stopped, (2) Vibration Sensors, (2) Motor Bearing Temps, Frequency, Amps, Volts, VFD LOR Switch Position
      5) Alarms:
         a) Local: General Alarm
         b) VFD: VFD Fault Alarm
         c) PCS: Motor High Temperature, (2) High Vibration Alarms, (2) High Bearing Temp Alarm, Low Suction Pressure, High Discharge Pressure, VFD Fault, Loss of Signal

15. EXISTING PROCESS CONTROL MODIFICATIONS
   a. Groundwater Wells and Pretreatment Systems
      1) General: Used to pump water to the plant and provide treatment upstream of the NF Building Softening process.

2) Control: Modify groundwater pumps level control to be based on Break Tank levels instead of Clearwell levels.
   a) Operator shall have the ability to select Break Tank 1 or Break Tank 2 Level as control variable.

16. EMERGENCY POWER

a. Automatic Transfer Switch
   1) General: Used to automatically transfer plant power to generator during a utility power outage.
   2) Control:
      a) Local: Per manufacturer
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Generator running and Automatic Transfer Switch in the Emergency Source position will initiate step loading logic for loads to be sequentially started.
   4) Monitoring:
      a) Local: Per manufacturer
      b) PCS: Utility Source Available, Emergency Source Available, Utility Source Connected, Emergency Source Connected
   5) Alarms:
      a) Local: Per manufacturer
      b) PCS: Not in Auto

b. Generator
   1) General: Used to supply emergency power to the plant during a utility power outage.
   2) Control:
      a) Local: Per manufacturer
      b) PCS: None
   3) Logic Interlocks/Permissives:
      a) Generator running and Automatic Transfer Switch in the Emergency Source position will initiate step loading logic for loads to be sequentially started.
   4) Monitoring:
      a) Local: Per manufacturer
      b) PCS: Running, Stopped, Remote
   5) Alarms:
      a) Local: Per manufacturer
      b) PCS: General Alarm, Not in Auto

17. CRITICAL ALARMS

a. General: Programming shall include the following as critical alarms. Critical alarms shall initiate a telephone call to designated personnel.
   1) Utility Power Failure
   2) PLC Failure Alarm
   3) Emergency NF Process Shutdown

3.2 EXAMINATION

A. Verification of Conditions: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Discrepancies: In the event any discrepancies are discovered, immediately notify the Owner's Representative in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 PREPARATION

A. Protection
   1. All equipment and materials shall be packed at the factory to protect each item from damage during shipment and storage.
   2. Provide blocking and cushioning materials to prevent damage during shipment.
   3. Panel mounted instruments and equipment to be installed inside enclosures, panels, or consoles shall be mounted and assembled at the panel manufacturer's facility.

3.4 INSTALLATION

A. General: Install equipment, as indicated, with manufacturer's written instructions and with recognized industry practices.

3.5 FIELD QUALITY CONTROL

A. Inspection: Provide for services of a qualified representative of the manufacturer to inspect and approve installation.

B. Tests: Upon completion of all inspections, and prior to acceptance, perform field tests outlined in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

C. Operational Demonstration: After completion of the field test, perform a 30-day operational demonstration as specified in Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.6 DEMONSTRATION

A. General: When all required tests have been performed and prior to final acceptance, the Contractor shall perform a 30-day operational demonstration in accordance with the requirements of Division 40 Section “Plant Instrumentation and Control System General Requirements”.

3.7 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.

B. Quantity: Provide spares for each type of module listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
   1. Processor Modules
   2. Power Supply
   3. Digital Input Modules

4. Digital Output Modules
5. Analog Input Modules
6. RTD Analog Input Modules
7. Analog Output Modules
8. Analog Input/Analog Output Modules
9. Flex I/O Modules
10. Flex I/O Module Terminal Blocks

C. Provide (6) OIT protective screen overlays.

D. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no cost.

3.8 PLC SYSTEM TRAINING

A. General.
1. Provide a training course customized for the control system hardware.
2. Provide training on the operation and maintenance of the control system hardware.
3. Provide training manuals for each attendee plus two additional manuals in archival preservation at the project site.
4. Include the following in each manual.
   a. An agenda
   b. Defined objectives for each lesson.
5. Provide all equipment, materials, and supplies used in the training.
6. For guidance in planning the required instruction, assume that attendees will have a high school education or equivalent and basic electrical maintenance knowledge.

B. Location, duration, and schedule.
1. Teach the course at the project site.
2. Provide one day of training for five personnel designated by the Owner.
3. Conduct training after completion of the Contractor's field testing.

3.9 INPUT/OUTPUT SCHEDULE

A. Abbreviations
1. AI = Analog Input
2. AO = Analog Output
3. CPU = Processor
4. DI = Digital Input
5. DO = Digital Output
6. RTD = RTD Analog Input

B. Installed spare inputs and outputs (I/O): In addition to the I/O listed below, provide a minimum of 10 percent installed.
1. All SPARE I/O shall be wired to terminal blocks within the PLC enclosure.

END OF SECTION 40 9443

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
CFB010	AI	0	2	0	HYPO STORAGE TANK 1 LEVEL
CFB010	AI	0	2	1	HYPO STORAGE TANK 2 LEVEL
CFB010	AI	0	2	2	HYPO STORAGE TANK 3 LEVEL
CFB010	AI	0	2	3	HYPO DAY TANK LEVEL
CFB010	AI	0	3	0	HYPO DISINFECTION FEED PUMP 1 SPEED FEEDBACK
CFB010	AI	0	3	1	HYPO DISINFECTION FEED PUMP 2 SPEED FEEDBACK
CFB010	AI	0	3	2	HYPO DISINFECTION FEED PUMP 3 SPEED FEEDBACK
CFB010	AI	0	4	0	HYPO OXIDATION FEED PUMP 1 SPEED FEEDBACK
CFB010	AI	0	4	1	HYPO OXIDATION FEED PUMP 2 SPEED FEEDBACK
CFB010	AI	0	4	2	FLUORIDE FEED PUMP 1 SPEED FEEDBACK
CFB010	AI	0	4	3	FLUORIDE FEED PUMP 2 SPEED FEEDBACK
CFB010	AO	0	6	0	HYPO DISINFECTION FEED PUMP 1 SPEED CMD
CFB010	AO	0	6	1	HYPO DISINFECTION FEED PUMP 2 SPEED CMD
CFB010	AO	0	6	2	HYPO DISINFECTION FEED PUMP 3 SPEED CMD
CFB010	AO	0	6	3	HYPO OXIDATION FEED PUMP 1 SPEED CMD
CFB010	AO	0	7	0	HYPO OXIDATION FEED PUMP 2 SPEED CMD
CFB010	AO	0	7	1	FLUORIDE FEED PUMP 1 SPEED CMD
CFB010	AO	0	7	2	FLUORIDE FEED PUMP 2 SPEED CMD
CFB010	DI	0	8	0	HYPO TRANSFER PUMP IN REMOTE
CFB010	DI	0	8	1	HYPO TRANSFER PUMP RUNNING
CFB010	DI	0	8	2	HYPO TRANSFER PUMP MOTOR HIGH TEMP
CFB010	DI	0	8	3	HYPO TRANSFER PUMP MOTOR OVERLOAD
CFB010	DI	0	8	4	HYPO TRANSFER SEQUENCE INITIATE
CFB010	DI	0	8	5	HYPO DAY TANK HIGH LEVEL
CFB010	DI	0	8	6	HYPO STORAGE TANK AREA WET FLOOR DETECTED
CFB010	DI	0	8	7	HYPO STOR TK 1 OUTLET VALVE IN REMOTE
CFB010	DI	0	8	8	HYPO STOR TK 1 OUTLET VALVE OPENED
CFB010	DI	0	8	9	HYPO STOR TK 1 OUTLET VALVE CLOSED
CFB010	DI	0	8	10	HYPO STOR TK 1 DILUTION WATER VALVE IN REMOTE
CFB010	DI	0	8	11	HYPO STOR TK 1 DILUTION WATER VALVE OPENED
CFB010	DI	0	8	12	HYPO STOR TK 1 DILUTION WATER VALVE CLOSED
CFB010	DI	0	8	13	HYPO STOR TK 1 RECIRC VALVE IN REMOTE
CFB010	DI	0	8	14	HYPO STOR TK 1 RECIRC VALVE OPENED
CFB010	DI	0	8	15	HYPO STOR TK 1 RECIRC VALVE CLOSED
CFB010	DI	0	9	0	HYPO STOR TK 2 OUTLET VALVE IN REMOTE
CFB010	DI	0	9	1	HYPO STOR TK 2 OUTLET VALVE OPENED
CFB010	DI	0	9	2	HYPO STOR TK 2 OUTLET VALVE CLOSED
CFB010	DI	0	9	9	HYPO STOR TK 2 DILUTION WATER VALVE IN REMOTE
CFB010	DI	0	9	10	HYPO STOR TK 2 DILUTION WATER VALVE OPENED
CFB010	DI	0	9	11	HYPO STOR TK 2 DILUTION WATER VALVE CLOSED
CFB010	DI	0	9	12	HYPO STOR TK 2 RECIRC VALVE IN REMOTE
CFB010	DI	0	9	13	HYPO STOR TK 2 RECIRC VALVE OPENED
CFB010	DI	0	9	14	HYPO STOR TK 2 RECIRC VALVE CLOSED
CFB010	DI	0	9	15	HYPO STOR TK 3 OUTLET VALVE IN REMOTE

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
CFB010	DI	0	10	0	HYPO STOR TK 3 OUTLET VALVE OPENED
CFB010	DI	0	10	1	HYPO STOR TK 3 OUTLET VALVE CLOSED
CFB010	DI	0	10	2	HYPO STOR TK 3 DILUTION WATER VALVE IN REMOTE
CFB010	DI	0	10	3	HYPO STOR TK 3 DILUTION WATER VALVE OPENED
CFB010	DI	0	10	4	HYPO STOR TK 3 DILUTION WATER VALVE CLOSED
CFB010	DI	0	10	5	HYPO STOR TK 3 RECIRC VALVE IN REMOTE
CFB010	DI	0	10	6	HYPO STOR TK 3 RECIRC VALVE OPENED
CFB010	DI	0	10	7	HYPO STOR TK 3 RECIRC VALVE CLOSED
CFB010	DI	0	10	8	HYPO DAY TANK INLET VALVE IN REMOTE
CFB010	DI	0	10	9	HYPO DAY TANK INLET VALVE OPENED
CFB010	DI	0	10	10	HYPO DAY TANK INLET VALVE CLOSED
CFB010	DI	0	11	0	HYPO DISINFECTION FEED PUMP 1 IN REMOTE
CFB010	DI	0	11	1	HYPO DISINFECTION FEED PUMP 1 RUNNING
CFB010	DI	0	11	2	HYPO DISINFECTION FEED PUMP 1 ALARM
CFB010	DI	0	11	3	HYPO DISINFECTION FEED PUMP 2 IN REMOTE
CFB010	DI	0	11	4	HYPO DISINFECTION FEED PUMP 2 RUNNING
CFB010	DI	0	11	5	HYPO DISINFECTION FEED PUMP 2 ALARM
CFB010	DI	0	11	6	HYPO DISINFECTION FEED PUMP 3 IN REMOTE
CFB010	DI	0	11	7	HYPO DISINFECTION FEED PUMP 3 RUNNING
CFB010	DI	0	11	8	HYPO DISINFECTION FEED PUMP 3 ALARM
CFB010	DI	0	11	9	HYPO OXIDATION FEED PUMP 1 IN REMOTE
CFB010	DI	0	11	10	HYPO OXIDATION FEED PUMP 1 RUNNING
CFB010	DI	0	11	11	HYPO OXIDATION FEED PUMP 1 ALARM
CFB010	DI	0	11	12	HYPO OXIDATION FEED PUMP 2 IN REMOTE
CFB010	DI	0	11	13	HYPO OXIDATION FEED PUMP 2 RUNNING
CFB010	DI	0	11	14	HYPO OXIDATION FEED PUMP 2 ALARM
CFB010	DO	0	12	0	HYPO TRANSFER PUMP START/STOP CMD
CFB010	DO	0	12	1	HYPO STOR TK 1 OUTLET VALVE OPEN CMD
CFB010	DO	0	12	2	HYPO STOR TK 1 OUTLET VALVE CLOSE CMD
CFB010	DO	0	12	3	HYPO STOR TK 1 DILUTION WATER VALVE OPEN CMD
CFB010	DO	0	13	0	HYPO STOR TK 1 DILUTION WATER VALVE CLOSE CMD
CFB010	DO	0	13	1	HYPO STOR TK 1 RECIRC VALVE OPEN CMD
CFB010	DO	0	13	2	HYPO STOR TK 1 RECIRC VALVE CLOSE CMD
CFB010	DO	0	13	3	HYPO STOR TK 2 OUTLET VALVE OPEN CMD
CFB010	DO	0	13	4	HYPO STOR TK 2 OUTLET VALVE CLOSE CMD
CFB010	DO	0	13	5	HYPO STOR TK 2 DILUTION WATER VALVE OPEN CMD
CFB010	DO	0	13	6	HYPO STOR TK 2 DILUTION WATER VALVE CLOSE CMD
CFB010	DO	0	13	7	HYPO STOR TK 2 RECIRC VALVE OPEN CMD
CFB010	DO	0	14	0	HYPO STOR TK 2 RECIRC VALVE CLOSE CMD
CFB010	DO	0	14	1	HYPO STOR TK 3 OUTLET VALVE OPEN CMD
CFB010	DO	0	14	2	HYPO STOR TK 3 OUTLET VALVE CLOSE CMD
CFB010	DO	0	14	3	HYPO STOR TK 3 DILUTION WATER VALVE OPEN CMD
CFB010	DO	0	14	4	HYPO STOR TK 3 DILUTION WATER VALVE CLOSE CMD
CFB010	DO	0	14	5	HYPO STOR TK 3 RECIRC VALVE OPEN CMD

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
CFB010	DO	0	14	6	HYPO STOR TK 3 RECIRC VALVE CLOSE CMD
CFB010	DO	0	14	7	HYPO DAY TANK INLET VALVE OPEN CMD
CFB010	DO	0	15	0	HYPO DAY TANK INLET VALVE CLOSE CMD
CFB010	DO	0	15	1	HYPO DISINFECTION FEED PUMP 1 START/STOP CMD
CFB010	DO	0	15	2	HYPO DISINFECTION FEED PUMP 2 START/STOP CMD
CFB010	DO	0	15	3	HYPO DISINFECTION FEED PUMP 3 START/STOP CMD
CFB010	DO	0	15	4	HYPO OXIDATION FEED PUMP 1 START/STOP CMD
CFB010	DO	0	15	5	HYPO OXIDATION FEED PUMP 2 START/STOP CMD
CFB010	DO	0	16	0	FLUORIDE TRANSFER PUMP START/STOP CMD
CFB010	DO	0	16	1	FLUORIDE STOR TK 1 OUTLET VALVE OPEN CMD
CFB010	DO	0	16	2	FLUORIDE STOR TK 1 OUTLET VALVE CLOSE CMD
CFB010	DO	0	16	3	FLUORIDE STOR TK 1 RECIRC VALVE OPEN CMD
CFB010	DO	0	16	4	FLUORIDE STOR TK 1 RECIRC VALVE CLOSE CMD
CFB010	DO	0	16	5	FLUORIDE STOR TK 2 OUTLET VALVE OPEN CMD
CFB010	DO	0	16	6	FLUORIDE STOR TK 2 OUTLET VALVE CLOSE CMD
CFB010	DO	0	16	7	FLUORIDE STOR TK 2 RECIRC VALVE OPEN CMD
CFB010	DO	0	17	0	FLUORIDE STOR TK 2 RECIRC VALVE CLOSE CMD
CFB010	DO	0	17	1	FLUORIDE DAY TANK INLET VALVE OPEN CMD
CFB010	DO	0	17	2	FLUORIDE DAY TANK INLET VALVE CLOSE CMD
CFB010	DO	0	17	3	FLUORIDE FEED PUMP 1 START/STOP CMD
CFB010	DO	0	17	4	FLUORIDE FEED PUMP 2 START/STOP CMD
CFB010	DI	0	18	0	FLUORIDE TRANSFER PUMP IN REMOTE
CFB010	DI	0	18	1	FLUORIDE TRANSFER PUMP RUNNING
CFB010	DI	0	18	2	FLUORIDE TRANSFER PUMP MOTOR HIGH TEMP
CFB010	DI	0	18	3	FLUORIDE TRANSFER PUMP MOTOR OVERLOAD
CFB010	DI	0	18	4	FLUORIDE TRANSFER SEQUENCE INITIATE
CFB010	DI	0	18	5	FLUORIDE DAY TANK HIGH LEVEL
CFB010	DI	0	18	6	FLUORIDE STORAGE TANK AREA WET FLOOR DETECTED
CFB010	DI	0	18	7	FLUORIDE STOR TK 1 OUTLET VALVE IN REMOTE
CFB010	DI	0	18	8	FLUORIDE STOR TK 1 OUTLET VALVE OPENED
CFB010	DI	0	18	9	FLUORIDE STOR TK 1 OUTLET VALVE CLOSED
CFB010	DI	0	18	10	FLUORIDE STOR TK 1 RECIRC VALVE IN REMOTE
CFB010	DI	0	18	11	FLUORIDE STOR TK 1 RECIRC VALVE OPENED
CFB010	DI	0	18	12	FLUORIDE STOR TK 1 RECIRC VALVE CLOSED
CFB010	DI	0	18	13	FLUORIDE STOR TK 2 OUTLET VALVE IN REMOTE
CFB010	DI	0	18	14	FLUORIDE STOR TK 2 OUTLET VALVE OPENED
CFB010	DI	0	18	15	FLUORIDE STOR TK 2 OUTLET VALVE CLOSED
CFB010	DI	0	19	0	FLUORIDE STOR TK 2 RECIRC VALVE IN REMOTE
CFB010	DI	0	19	1	FLUORIDE STOR TK 2 RECIRC VALVE OPENED
CFB010	DI	0	19	2	FLUORIDE STOR TK 2 RECIRC VALVE CLOSED
CFB010	DI	0	19	3	FLUORIDE DAY TANK INLET VALVE IN REMOTE
CFB010	DI	0	19	4	FLUORIDE DAY TANK INLET VALVE OPENED
CFB010	DI	0	19	5	FLUORIDE DAY TANK INLET VALVE CLOSED
CFB010	DI	0	19	6	FLUORIDE FEED PUMP 1 IN REMOTE

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
CFB010	DI	0	19	7	FLUORIDE FEED PUMP 1 RUNNING
CFB010	DI	0	19	8	FLUORIDE FEED PUMP 1 ALARM
CFB010	DI	0	19	9	FLUORIDE FEED PUMP 2 IN REMOTE
CFB010	DI	0	19	10	FLUORIDE FEED PUMP 2 RUNNING
CFB010	DI	0	19	11	FLUORIDE FEED PUMP 2 ALARM
CFB010	DI	0	19	12	CHEMICAL FEED BUILDING ETHERNET SWITCH ALARM
CFB010	AI	0	20	0	HYPO DILUTION WATER FLOW
CFB010	AI	0	20	1	HYPO CHEMICAL ROOM TEMPERATURE
CFB010	AI	0	21	0	FLUORIDE STORAGE TANK 1 LEVEL
CFB010	AI	0	21	1	FLUORIDE STORAGE TANK 2 LEVEL
CFB010	AI	0	21	2	FLUORIDE DAY TANK WEIGHT
CTB010	DI			SPARE	CONTROL BUILDING ETHERNET SWITCH ALARM
EWF010	DI			SPARE	EAST WELL FIELD ETHERNET SWITCH ALARM
GFB010	DI			SPARE	GRAVITY FILTER BUILDING ETHERNET SWITCH ALARM
HSB010	DI			SPARE	HIGH SERVICE PUMP BUIDLING ETHERNET SWITCH ALARM
HSB010	DI			SPARE	HIGH SERVICE PUMP 5 IN REMOTE
HSB010	DI			SPARE	HIGH SERVICE PUMP 5 RUNNING
HSB010	DI			SPARE	HIGH SERVICE PUMP 5 MOTOR HIGH TEMP
HSB010	DI			SPARE	HIGH SERVICE PUMP 5 HIGH VIBRATION
HSB010	DI			SPARE	HIGH SERVICE PUMP 5 HIGH DISCHARGE PRESSURE
HSB010	DI			SPARE	HIGH SERVICE PUMP 5 VFD FAULT
HSB010	DO			SPARE	HIGH SERVICE PUMP 5 START/STOP CMD
HSB010	AI			SPARE	HIGH SERVICE PUMP 5 SPEED FEEDBACK
HSB010	AO			SPARE	HIGH SERVICE PUMP 5 SPEED CMD
MAB010	DI			SPARE	MAINTENANCE BUILDING ETHERNET SWITCH ALARM
NFB010	DI	0	1	0	BREAK TANK PUMP 1 IN REMOTE
NFB010	DI	0	1	1	BREAK TANK PUMP 1 RUNNING
NFB010	DI	0	1	2	BREAK TANK PUMP 1 MOTOR HIGH TEMP
NFB010	DI	0	1	3	BREAK TANK PUMP 1 HIGH DISCHARGE PRESSURE
NFB010	DI	0	1	4	BREAK TANK PUMP 1 VFD FAULT
NFB010	DI	0	1	5	BREAK TANK PUMP 3 IN REMOTE
NFB010	DI	0	1	6	BREAK TANK PUMP 3 RUNNING
NFB010	DI	0	1	7	BREAK TANK PUMP 3 MOTOR HIGH TEMP
NFB010	DI	0	1	8	BREAK TANK PUMP 3 HIGH DISCHARGE PRESSURE
NFB010	DI	0	1	9	BREAK TANK PUMP 3 VFD FAULT
NFB010	DI	0	1	10	BREAK TANK 1 LOW LEVEL ALARM
NFB010	DI	0	2	0	BREAK TANK PUMP 4 IN REMOTE
NFB010	DI	0	2	1	BREAK TANK PUMP 4 RUNNING

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	DI	0	2	2	BREAK TANK PUMP 4 MOTOR HIGH TEMP
NFB010	DI	0	2	3	BREAK TANK PUMP 4 HIGH DISCHARGE PRESSURE
NFB010	DI	0	2	4	BREAK TANK PUMP 4 VFD FAULT
NFB010	DI	0	2	5	BREAK TANK PUMP 6 IN REMOTE
NFB010	DI	0	2	6	BREAK TANK PUMP 6 RUNNING
NFB010	DI	0	2	7	BREAK TANK PUMP 6 MOTOR HIGH TEMP
NFB010	DI	0	2	8	BREAK TANK PUMP 6 HIGH DISCHARGE PRESSURE
NFB010	DI	0	2	9	BREAK TANK PUMP 6 VFD FAULT
NFB010	DI	0	2	10	BREAK TANK 2 LOW LEVEL ALARM
NFB010	DI	0	3	0	NF FEED PUMP 1 IN REMOTE
NFB010	DI	0	3	1	NF FEED PUMP 1 RUNNING
NFB010	DI	0	3	2	NF FEED PUMP 1 MOTOR HIGH TEMP
NFB010	DI	0	3	3	NF FEED PUMP 1 LOW SUCTION PRESSURE
NFB010	DI	0	3	4	NF FEED PUMP 1 HIGH DISCHARGE PRESSURE
NFB010	DI	0	3	5	NF FEED PUMP 1 VFD FAULT
NFB010	DI	0	3	6	NF FEED PUMP 2 IN REMOTE
NFB010	DI	0	3	7	NF FEED PUMP 2 RUNNING
NFB010	DI	0	3	8	NF FEED PUMP 2 MOTOR HIGH TEMP
NFB010	DI	0	3	9	NF FEED PUMP 2 LOW SUCTION PRESSURE
NFB010	DI	0	3	10	NF FEED PUMP 2 HIGH DISCHARGE PRESSURE
NFB010	DI	0	3	11	NF FEED PUMP 2 VFD FAULT
NFB010	DI	0	4	0	NF FEED PUMP 3 IN REMOTE
NFB010	DI	0	4	1	NF FEED PUMP 3 RUNNING
NFB010	DI	0	4	2	NF FEED PUMP 3 MOTOR HIGH TEMP
NFB010	DI	0	4	3	NF FEED PUMP 3 LOW SUCTION PRESSURE
NFB010	DI	0	4	4	NF FEED PUMP 3 HIGH DISCHARGE PRESSURE
NFB010	DI	0	4	5	NF FEED PUMP 3 VFD FAULT
NFB010	DI	0	4	6	NF FEED PUMP 4 IN REMOTE
NFB010	DI	0	4	7	NF FEED PUMP 4 RUNNING
NFB010	DI	0	4	8	NF FEED PUMP 4 MOTOR HIGH TEMP
NFB010	DI	0	4	9	NF FEED PUMP 4 LOW SUCTION PRESSURE
NFB010	DI	0	4	10	NF FEED PUMP 4 HIGH DISCHARGE PRESSURE
NFB010	DI	0	4	11	NF FEED PUMP 4 VFD FAULT
NFB010	DI	0	5	0	NF FEED PUMP 5 IN REMOTE
NFB010	DI	0	5	1	NF FEED PUMP 5 RUNNING
NFB010	DI	0	5	2	NF FEED PUMP 5 MOTOR HIGH TEMP
NFB010	DI	0	5	3	NF FEED PUMP 5 LOW SUCTION PRESSURE
NFB010	DI	0	5	4	NF FEED PUMP 5 HIGH DISCHARGE PRESSURE
NFB010	DI	0	5	5	NF FEED PUMP 5 VFD FAULT
NFB010	DI	0	5	6	NF FEED PUMP 6 IN REMOTE
NFB010	DI	0	5	7	NF FEED PUMP 6 RUNNING
NFB010	DI	0	5	8	NF FEED PUMP 6 MOTOR HIGH TEMP
NFB010	DI	0	5	9	NF FEED PUMP 6 LOW SUCTION PRESSURE
NFB010	DI	0	5	10	NF FEED PUMP 6 HIGH DISCHARGE PRESSURE

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	DI	0	5	11	NF FEED PUMP 6 VFD FAULT
NFB010	DI	0	6	0	DEGASIFIER BLOWER 1 IN REMOTE
NFB010	DI	0	6	1	DEGASIFIER BLOWER 1 RUNNING
NFB010	DI	0	6	2	DEGASIFIER BLOWER 1 MOTOR HIGH TEMP
NFB010	DI	0	6	3	DEGASIFIER BLOWER 1 INLET SCREEN HIGH DIFFERENTIAL PRESSURE
NFB010	DI	0	6	4	DEGASIFIER BLOWER 1 MOTOR OVERLOAD
NFB010	DI	0	6	5	DEGASIFIER BLOWER 2 IN REMOTE
NFB010	DI	0	6	6	DEGASIFIER BLOWER 2 RUNNING
NFB010	DI	0	6	7	DEGASIFIER BLOWER 2 MOTOR HIGH TEMP
NFB010	DI	0	6	8	DEGASIFIER BLOWER 2 INLET SCREEN HIGH DIFFERENTIAL PRESSURE
NFB010	DI	0	6	9	DEGASIFIER BLOWER 2 MOTOR OVERLOAD
NFB010	DI	0	7	0	PHOS TRANSFER PUMP IN REMOTE
NFB010	DI	0	7	1	PHOS TRANSFER PUMP RUNNING
NFB010	DI	0	7	2	PHOS TRANSFER PUMP MOTOR HIGH TEMP
NFB010	DI	0	7	3	PHOS TRANSFER PUMP MOTOR OVERLOAD
NFB010	DI	0	7	4	PHOS TRANSFER SEQUENCE INITIATE
NFB010	DI	0	7	5	PHOS DAY TANK HIGH LEVEL
NFB010	DI	0	7	6	PHOS CHEMICAL ROOM EYEWASH ACTIVATED
NFB010	DI	0	7	7	PHOS STORAGE TANK AREA WET FLOOR DETECTED
NFB010	DI	0	7	8	PHOS STOR TK 1 OUTLET VALVE IN REMOTE
NFB010	DI	0	7	9	PHOS STOR TK 1 OUTLET VALVE OPENED
NFB010	DI	0	7	10	PHOS STOR TK 1 OUTLET VALVE CLOSED
NFB010	DI	0	7	11	PHOS STOR TK 1 RECIRC VALVE IN REMOTE
NFB010	DI	0	7	12	PHOS STOR TK 1 RECIRC VALVE OPENED
NFB010	DI	0	7	13	PHOS STOR TK 1 RECIRC VALVE CLOSED
NFB010	DI	0	8	0	PHOS STOR TK 2 OUTLET VALVE IN REMOTE
NFB010	DI	0	8	1	PHOS STOR TK 2 OUTLET VALVE OPENED
NFB010	DI	0	8	2	PHOS STOR TK 2 OUTLET VALVE CLOSED
NFB010	DI	0	8	3	PHOS STOR TK 2 RECIRC VALVE IN REMOTE
NFB010	DI	0	8	4	PHOS STOR TK 2 RECIRC VALVE OPENED
NFB010	DI	0	8	5	PHOS STOR TK 2 RECIRC VALVE CLOSED
NFB010	DI	0	8	6	PHOS DAY TANK INLET VALVE IN REMOTE
NFB010	DI	0	8	7	PHOS DAY TANK INLET VALVE OPENED
NFB010	DI	0	8	8	PHOS DAY TANK INLET VALVE CLOSED
NFB010	DI	0	8	9	PHOS FEED PUMP 1 IN REMOTE
NFB010	DI	0	8	10	PHOS FEED PUMP 1 RUNNING
NFB010	DI	0	8	11	PHOS FEED PUMP 1 ALARM
NFB010	DI	0	8	12	PHOS FEED PUMP 2 IN REMOTE
NFB010	DI	0	8	13	PHOS FEED PUMP 2 RUNNING
NFB010	DI	0	8	14	PHOS FEED PUMP 2 ALARM
NFB010	DI	0	9	0	CAUSTIC SODA TRANSFER PUMP IN REMOTE
NFB010	DI	0	9	1	CAUSTIC SODA TRANSFER PUMP RUNNING
NFB010	DI	0	9	2	CAUSTIC SODA TRANSFER PUMP MOTOR HIGH TEMP
NFB010	DI	0	9	3	CAUSTIC SODA TRANSFER PUMP MOTOR OVERLOAD

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	DI	0	9	4	CAUSTIC SODA TRANSFER SEQUENCE INITIATE
NFB010	DI	0	9	5	CAUSTIC SODA DAY TANK HIGH LEVEL
NFB010	DI	0	9	6	CAUSTIC SODA CHEMICAL ROOM EYEWASH ACTIVATED
NFB010	DI	0	9	7	CAUSTIC SODA STORAGE TANK AREA WET FLOOR DETECTED
NFB010	DI	0	9	8	CAUSTIC SODA STOR TK 1 OUTLET VALVE IN REMOTE
NFB010	DI	0	9	9	CAUSTIC SODA STOR TK 1 OUTLET VALVE OPENED
NFB010	DI	0	9	10	CAUSTIC SODA STOR TK 1 OUTLET VALVE CLOSED
NFB010	DI	0	9	11	CAUSTIC SODA STOR TK 1 RECIRC VALVE IN REMOTE
NFB010	DI	0	9	12	CAUSTIC SODA STOR TK 1 RECIRC VALVE OPENED
NFB010	DI	0	9	13	CAUSTIC SODA STOR TK 1 RECIRC VALVE CLOSED
NFB010	DI	0	10	0	CAUSTIC SODA STOR TK 2 OUTLET VALVE IN REMOTE
NFB010	DI	0	10	1	CAUSTIC SODA STOR TK 2 OUTLET VALVE OPENED
NFB010	DI	0	10	2	CAUSTIC SODA STOR TK 2 OUTLET VALVE CLOSED
NFB010	DI	0	10	3	CAUSTIC SODA STOR TK 2 RECIRC VALVE IN REMOTE
NFB010	DI	0	10	4	CAUSTIC SODA STOR TK 2 RECIRC VALVE OPENED
NFB010	DI	0	10	5	CAUSTIC SODA STOR TK 2 RECIRC VALVE CLOSED
NFB010	DI	0	10	6	CAUSTIC SODA DAY TANK INLET VALVE IN REMOTE
NFB010	DI	0	10	7	CAUSTIC SODA DAY TANK INLET VALVE OPENED
NFB010	DI	0	10	8	CAUSTIC SODA DAY TANK INLET VALVE CLOSED
NFB010	DI	0	10	9	CAUSTIC SODA FEED PUMP 1 IN REMOTE
NFB010	DI	0	10	10	CAUSTIC SODA FEED PUMP 1 RUNNING
NFB010	DI	0	10	11	CAUSTIC SODA FEED PUMP 1 ALARM
NFB010	DI	0	10	12	CAUSTIC SODA FEED PUMP 2 IN REMOTE
NFB010	DI	0	10	13	CAUSTIC SODA FEED PUMP 2 RUNNING
NFB010	DI	0	10	14	CAUSTIC SODA FEED PUMP 2 ALARM
NFB010	DI	0	11	0	SODIUM BISULFITE TRANSFER PUMP IN REMOTE
NFB010	DI	0	11	1	SODIUM BISULFITE TRANSFER PUMP RUNNING
NFB010	DI	0	11	2	SODIUM BISULFITE TRANSFER PUMP MOTOR HIGH TEMP
NFB010	DI	0	11	3	SODIUM BISULFITE TRANSFER PUMP MOTOR OVERLOAD
NFB010	DI	0	11	4	SODIUM BISULFITE TRANSFER SEQUENCE INITIATE
NFB010	DI	0	11	5	SODIUM BISULFITE DAY TANK HIGH LEVEL
NFB010	DI	0	11	6	SODIUM BISULFITE CHEMICAL ROOM EYEWASH ACTIVATED
NFB010	DI	0	11	7	SODIUM BISULFITE STORAGE TANK AREA WET FLOOR DETECTED
NFB010	DI	0	11	8	SODIUM BISULFITE STOR TK 1 OUTLET VALVE IN REMOTE
NFB010	DI	0	11	9	SODIUM BISULFITE STOR TK 1 OUTLET VALVE OPENED
NFB010	DI	0	11	10	SODIUM BISULFITE STOR TK 1 OUTLET VALVE CLOSED
NFB010	DI	0	11	11	SODIUM BISULFITE STOR TK 1 RECIRC VALVE IN REMOTE
NFB010	DI	0	11	12	SODIUM BISULFITE STOR TK 1 RECIRC VALVE OPENED
NFB010	DI	0	11	13	SODIUM BISULFITE STOR TK 1 RECIRC VALVE CLOSED
NFB010	DI	0	12	0	SODIUM BISULFITE STOR TK 2 OUTLET VALVE IN REMOTE
NFB010	DI	0	12	1	SODIUM BISULFITE STOR TK 2 OUTLET VALVE OPENED
NFB010	DI	0	12	2	SODIUM BISULFITE STOR TK 2 OUTLET VALVE CLOSED
NFB010	DI	0	12	3	SODIUM BISULFITE STOR TK 2 RECIRC VALVE IN REMOTE
NFB010	DI	0	12	4	SODIUM BISULFITE STOR TK 2 RECIRC VALVE OPENED

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	DI	0	12	5	SODIUM BISULFITE STOR TK 2 RECIRC VALVE CLOSED
NFB010	DI	0	12	6	SODIUM BISULFITE DAY TANK INLET VALVE IN REMOTE
NFB010	DI	0	12	7	SODIUM BISULFITE DAY TANK INLET VALVE OPENED
NFB010	DI	0	12	8	SODIUM BISULFITE DAY TANK INLET VALVE CLOSED
NFB010	DI	0	12	9	SODIUM BISULFITE FEED PUMP 1 IN REMOTE
NFB010	DI	0	12	10	SODIUM BISULFITE FEED PUMP 1 RUNNING
NFB010	DI	0	12	11	SODIUM BISULFITE FEED PUMP 1 ALARM
NFB010	DI	0	12	12	SODIUM BISULFITE FEED PUMP 2 IN REMOTE
NFB010	DI	0	12	13	SODIUM BISULFITE FEED PUMP 2 RUNNING
NFB010	DI	0	12	14	SODIUM BISULFITE FEED PUMP 2 ALARM
NFB010	DI	0	13	0	ANTISCALANT TRANSFER PUMP IN REMOTE
NFB010	DI	0	13	1	ANTISCALANT TRANSFER PUMP RUNNING
NFB010	DI	0	13	2	ANTISCALANT TRANSFER PUMP MOTOR HIGH TEMP
NFB010	DI	0	13	3	ANTISCALANT TRANSFER PUMP MOTOR OVERLOAD
NFB010	DI	0	13	4	ANTISCALANT TRANSFER SEQUENCE INITIATE
NFB010	DI	0	13	5	ANTISCALANT DAY TANK HIGH LEVEL
NFB010	DI	0	13	6	ANTISCALANT FEED PUMP 1 IN REMOTE
NFB010	DI	0	13	7	ANTISCALANT FEED PUMP 1 RUNNING
NFB010	DI	0	13	8	ANTISCALANT FEED PUMP 1 ALARM
NFB010	DI	0	13	9	ANTISCALANT FEED PUMP 2 IN REMOTE
NFB010	DI	0	13	10	ANTISCALANT FEED PUMP 2 RUNNING
NFB010	DI	0	13	11	ANTISCALANT FEED PUMP 2 ALARM
NFB010	DI	0	13	12	ANTISCALANT INJECTION FLOW SWITCH ACTIVE
NFB010	DI	0	14	0	NF BYPASS FLOW CONTROL VALVE IN REMOTE
NFB010	DI	0	14	1	NF BYPASS FLOW CONTROL VALVE OPENED
NFB010	DI	0	14	2	NF BYPASS FLOW CONTROL VALVE CLOSED
NFB010	DI	0	14	3	NF BYPASS FLOW CONTROL VALVE FAULT
NFB010	DI	0	14	4	NFB TO DEGASIFIERS FLOW CONTROL VALVE IN REMOTE
NFB010	DI	0	14	5	NFB TO DEGASIFIERS FLOW CONTROL VALVE OPENED
NFB010	DI	0	14	6	NFB TO DEGASIFIERS FLOW CONTROL VALVE CLOSED
NFB010	DI	0	14	7	NFB TO DEGASIFIERS FLOW CONTROL VALVE FAULT
NFB010	DI	0	14	8	NFB TO DEGASIFIERS ISOLATION VALVE IN REMOTE
NFB010	DI	0	14	9	NFB TO DEGASIFIERS ISOLATION VALVE OPENED
NFB010	DI	0	14	10	NFB TO DEGASIFIERS ISOLATION VALVE CLOSED
NFB010	DI	0	14	11	NFB TO DEGASIFIERS ISOLATION VALVE FAULT
NFB010	DI	0	14	12	CHEMICAL UNLOAD AREA NORTH EYEWASH ACTIVATED
NFB010	DI	0	14	13	CHEMICAL UNLOAD AREA SOUTH EYEWASH ACTIVATED
NFB010	DI	0	15	0	GENERATOR IN REMOTE MODE
NFB010	DI	0	15	1	GENERATOR RUNNING
NFB010	DI	0	15	2	GENERATOR ALARM
NFB010	DI	0	15	3	ATS IN REMOTE MODE
NFB010	DI	0	15	4	ATS NORMAL SOURCE AVAILABLE
NFB010	DI	0	15	5	ATS EMERGENCY SOURCE AVAILABLE
NFB010	DI	0	15	6	ATS NORMAL SOURCE CONNECTED

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	DI	0	15	7	ATS EMERGENCY SOURCE CONNECTED
NFB010	DI	0	15	8	NFB BASEMENT SUMP HIGH LEVEL ALARM
NFB010	DI	0	15	9	NFB BASEMENT SUMP PUMP 1 RUNNING
NFB010	DI	0	15	10	NFB BASEMENT SUMP PUMP 2 RUNNING
NFB010	DI	0	15	11	NF-NSE SCADA ETHERNET SWITCH ALARM
NFB010	DI	0	15	12	NF-NSE SECURITY ETHERNET SWITCH ALARM
NFB010	DI	0	15	13	NF BUILDING ACP ETHERNET SWITCH ALARM
NFB010	DI	0	15	14	MCC-6 ETHERNET SWITCH 1 ALARM
NFB010	DI	0	15	15	MCC-6 ETHERNET SWITCH 2 ALARM
NFB010	DO	1	5	0	BREAK TANK PUMP 1 START/STOP CMD
NFB010	DO	1	5	1	BREAK TANK PUMP 3 START/STOP CMD
NFB010	DO	1	5	2	BREAK TANK PUMP 4 START/STOP CMD
NFB010	DO	1	5	3	BREAK TANK PUMP 6 START/STOP CMD
NFB010	DO	1	5	4	NF FEED PUMP 1 START/STOP CMD
NFB010	DO	1	5	5	NF FEED PUMP 2 START/STOP CMD
NFB010	DO	1	5	6	NF FEED PUMP 3 START/STOP CMD
NFB010	DO	1	5	7	NF FEED PUMP 4 START/STOP CMD
NFB010	DO	1	5	8	NF FEED PUMP 5 START/STOP CMD
NFB010	DO	1	5	9	NF FEED PUMP 6 START/STOP CMD
NFB010	DO	1	5	10	DEGASIFIER BLOWER 1 START/STOP CMD
NFB010	DO	1	5	11	DEGASIFIER BLOWER 2 START/STOP CMD
NFB010	DO	1	6	0	PHOS TRANSFER PUMP START/STOP CMD
NFB010	DO	1	6	1	PHOS STOR TK 1 OUTLET VALVE OPEN CMD
NFB010	DO	1	6	2	PHOS STOR TK 1 OUTLET VALVE CLOSE CMD
NFB010	DO	1	6	3	PHOS STOR TK 1 RECIRC VALVE OPEN CMD
NFB010	DO	1	6	4	PHOS STOR TK 1 RECIRC VALVE CLOSE CMD
NFB010	DO	1	6	5	PHOS STOR TK 2 OUTLET VALVE OPEN CMD
NFB010	DO	1	6	6	PHOS STOR TK 2 OUTLET VALVE CLOSE CMD
NFB010	DO	1	6	7	PHOS STOR TK 2 RECIRC VALVE OPEN CMD
NFB010	DO	1	6	8	PHOS STOR TK 2 RECIRC VALVE CLOSE CMD
NFB010	DO	1	6	9	PHOS DAY TANK INLET VALVE OPEN CMD
NFB010	DO	1	6	10	PHOS DAY TANK INLET VALVE CLOSE CMD
NFB010	DO	1	6	11	PHOS FEED PUMP 1 START/STOP CMD
NFB010	DO	1	6	12	PHOS FEED PUMP 2 START/STOP CMD
NFB010	DO	1	7	0	CAUSTIC SODA TRANSFER PUMP START/STOP CMD
NFB010	DO	1	7	1	CAUSTIC SODA STOR TK 1 OUTLET VALVE OPEN CMD
NFB010	DO	1	7	2	CAUSTIC SODA STOR TK 1 OUTLET VALVE CLOSE CMD
NFB010	DO	1	7	3	CAUSTIC SODA STOR TK 1 RECIRC VALVE OPEN CMD
NFB010	DO	1	7	4	CAUSTIC SODA STOR TK 1 RECIRC VALVE CLOSE CMD
NFB010	DO	1	7	5	CAUSTIC SODA STOR TK 2 OUTLET VALVE OPEN CMD
NFB010	DO	1	7	6	CAUSTIC SODA STOR TK 2 OUTLET VALVE CLOSE CMD
NFB010	DO	1	7	7	CAUSTIC SODA STOR TK 2 RECIRC VALVE OPEN CMD
NFB010	DO	1	7	8	CAUSTIC SODA STOR TK 2 RECIRC VALVE CLOSE CMD
NFB010	DO	1	7	9	CAUSTIC SODA DAY TANK INLET VALVE OPEN CMD

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	DO	1	7	10	CAUSTIC SODA DAY TANK INLET VALVE CLOSE CMD
NFB010	DO	1	7	11	CAUSTIC SODA CARRIER WATER VALVE OPEN/CLOSE CMD
NFB010	DO	1	7	12	CAUSTIC SODA FEED PUMP 1 START/STOP CMD
NFB010	DO	1	7	13	CAUSTIC SODA FEED PUMP 2 START/STOP CMD
NFB010	DO	1	8	0	SODIUM BISULFITE TRANSFER PUMP START/STOP CMD
NFB010	DO	1	8	1	SODIUM BISULFITE STOR TK 1 OUTLET VALVE OPEN CMD
NFB010	DO	1	8	2	SODIUM BISULFITE STOR TK 1 OUTLET VALVE CLOSE CMD
NFB010	DO	1	8	3	SODIUM BISULFITE STOR TK 1 RECIRC VALVE OPEN CMD
NFB010	DO	1	8	4	SODIUM BISULFITE STOR TK 1 RECIRC VALVE CLOSE CMD
NFB010	DO	1	8	5	SODIUM BISULFITE STOR TK 2 OUTLET VALVE OPEN CMD
NFB010	DO	1	8	6	SODIUM BISULFITE STOR TK 2 OUTLET VALVE CLOSE CMD
NFB010	DO	1	8	7	SODIUM BISULFITE STOR TK 2 RECIRC VALVE OPEN CMD
NFB010	DO	1	8	8	SODIUM BISULFITE STOR TK 2 RECIRC VALVE CLOSE CMD
NFB010	DO	1	8	9	SODIUM BISULFITE DAY TANK INLET VALVE OPEN CMD
NFB010	DO	1	8	10	SODIUM BISULFITE DAY TANK INLET VALVE CLOSE CMD
NFB010	DO	1	8	11	SODIUM BISULFITE FEED PUMP 1 START/STOP CMD
NFB010	DO	1	8	12	SODIUM BISULFITE FEED PUMP 2 START/STOP CMD
NFB010	DO	1	9	0	ANTISCALANT TRANSFER PUMP START/STOP CMD
NFB010	DO	1	9	1	ANTISCALANT FEED PUMP 1 START/STOP CMD
NFB010	DO	1	9	2	ANTISCALANT FEED PUMP 2 START/STOP CMD
NFB010	DO	1	9	3	NFB TO DEGASIFIERS ISOLATION VALVE OPEN CMD
NFB010	DO	1	9	4	NFB TO DEGASIFIERS ISOLATION VALVE CLOSE CMD
NFB010	AI	2	1	0	BREAK TANK PUMP 1 SPEED FEEDBACK
NFB010	AI	2	1	1	BREAK TANK PUMP 1 DISCHARGE PRESSURE
NFB010	AI	2	1	2	BREAK TANK PUMP 3 SPEED FEEDBACK
NFB010	AI	2	1	3	BREAK TANK PUMP 3 DISCHARGE PRESSURE
NFB010	AI	2	1	4	BREAK TANK PUMP 4 SPEED FEEDBACK
NFB010	AI	2	1	5	BREAK TANK PUMP 4 DISCHARGE PRESSURE
NFB010	AI	2	1	6	BREAK TANK PUMP 6 SPEED FEEDBACK
NFB010	AI	2	1	7	BREAK TANK PUMP 6 DISCHARGE PRESSURE
NFB010	AI	2	2	0	NF FEED PUMP 1 SPEED FEEDBACK
NFB010	AI	2	2	1	NF FEED PUMP 1 SUCTION PRESSURE
NFB010	AI	2	2	2	NF FEED PUMP 1 DISCHARGE PRESSURE
NFB010	AI	2	2	3	NF FEED PUMP 1 VIBRATION SENSOR 1
NFB010	AI	2	2	4	NF FEED PUMP 1 VIBRATION SENSOR 2
NFB010	AI	2	2	5	BREAK TANK 1 LEVEL
NFB010	AI	2	2	6	BREAK TANK 2 LEVEL
NFB010	AI	2	3	0	NF FEED PUMP 2 SPEED FEEDBACK
NFB010	AI	2	3	1	NF FEED PUMP 2 SUCTION PRESSURE
NFB010	AI	2	3	2	NF FEED PUMP 2 DISCHARGE PRESSURE
NFB010	AI	2	3	3	NF FEED PUMP 2 VIBRATION SENSOR 1
NFB010	AI	2	3	4	NF FEED PUMP 2 VIBRATION SENSOR 2
NFB010	AI	2	4	0	NF FEED PUMP 3 SPEED FEEDBACK
NFB010	AI	2	4	1	NF FEED PUMP 3 SUCTION PRESSURE

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	AI	2	4	2	NF FEED PUMP 3 DISCHARGE PRESSURE
NFB010	AI	2	4	3	NF FEED PUMP 3 VIBRATION SENSOR 1
NFB010	AI	2	4	4	NF FEED PUMP 3 VIBRATION SENSOR 2
NFB010	AI	2	5	0	NF FEED PUMP 4 SPEED FEEDBACK
NFB010	AI	2	5	1	NF FEED PUMP 4 SUCTION PRESSURE
NFB010	AI	2	5	2	NF FEED PUMP 4 DISCHARGE PRESSURE
NFB010	AI	2	5	3	NF FEED PUMP 4 VIBRATION SENSOR 1
NFB010	AI	2	5	4	NF FEED PUMP 4 VIBRATION SENSOR 2
NFB010	AI	2	6	0	NF FEED PUMP 5 SPEED FEEDBACK
NFB010	AI	2	6	1	NF FEED PUMP 5 SUCTION PRESSURE
NFB010	AI	2	6	2	NF FEED PUMP 5 DISCHARGE PRESSURE
NFB010	AI	2	6	3	NF FEED PUMP 5 VIBRATION SENSOR 1
NFB010	AI	2	6	4	NF FEED PUMP 5 VIBRATION SENSOR 2
NFB010	AI	2	7	0	NF FEED PUMP 6 SPEED FEEDBACK
NFB010	AI	2	7	1	NF FEED PUMP 6 SUCTION PRESSURE
NFB010	AI	2	7	2	NF FEED PUMP 6 DISCHARGE PRESSURE
NFB010	AI	2	7	3	NF FEED PUMP 6 VIBRATION SENSOR 1
NFB010	AI	2	7	4	NF FEED PUMP 6 VIBRATION SENSOR 2
NFB010	AI	2	8	0	CARTRIDGE FILTER 1 DIFFERENTIAL PRESSURE
NFB010	AI	2	8	1	CARTRIDGE FILTER 2 DIFFERENTIAL PRESSURE
NFB010	AI	2	8	2	CARTRIDGE FILTER 3 DIFFERENTIAL PRESSURE
NFB010	AI	2	8	3	CARTRIDGE FILTER 4 DIFFERENTIAL PRESSURE
NFB010	AI	2	8	4	DEGASIFIER 1 INLET SCREEN DIFFERENTIAL PRESSURE
NFB010	AI	2	8	5	DEGASIFIER 2 INLET SCREEN DIFFERENTIAL PRESSURE
NFB010	AI	2	9	0	PHOS STORAGE TANK 1 LEVEL
NFB010	AI	2	9	1	PHOS STORAGE TANK 2 LEVEL
NFB010	AI	2	9	2	PHOS FEED PUMP 1 SPEED FEEDBACK
NFB010	AI	2	9	3	PHOS FEED PUMP 2 SPEED FEEDBACK
NFB010	AI	2	9	4	PHOS DAY TANK WEIGHT
NFB010	AI	2	10	0	CAUSTIC SODA STORAGE TANK 1 LEVEL
NFB010	AI	2	10	1	CAUSTIC SODA STORAGE TANK 2 LEVEL
NFB010	AI	2	10	2	CAUSTIC SODA FEED PUMP 1 SPEED FEEDBACK
NFB010	AI	2	10	3	CAUSTIC SODA FEED PUMP 2 SPEED FEEDBACK
NFB010	AI	2	10	4	CAUSTIC SODA DAY TANK WEIGHT
NFB010	AI	2	10	5	CAUSTIC SODA CHEMICAL ROOM TEMPERATURE
NFB010	AI	2	11	0	SODIUM BISULFITE STORAGE TANK 1 LEVEL
NFB010	AI	2	11	1	SODIUM BISULFITE STORAGE TANK 2 LEVEL
NFB010	AI	2	11	2	SODIUM BISULFITE FEED PUMP 1 SPEED FEEDBACK
NFB010	AI	2	11	3	SODIUM BISULFITE FEED PUMP 2 SPEED FEEDBACK
NFB010	AI	2	11	4	SODIUM BISULFITE DAY TANK WEIGHT
NFB010	AI	2	11	5	SODIUM BISULFITE CHEMICAL ROOM TEMPERATURE
NFB010	AI	2	12	0	ANTISCALANT FEED PUMP 1 SPEED FEEDBACK
NFB010	AI	2	12	1	ANTISCALANT FEED PUMP 2 SPEED FEEDBACK
NFB010	AI	2	12	2	ANTISCALANT DAY TANK WEIGHT

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	AI	2	12	3	ANTISCALANT INJECTION FLOW
NFB010	AI	2	12	4	NF BYPASS FLOW CONTROL VALVE POSITION FEEDBACK
NFB010	AI	2	12	5	NFB TO DEGASIFIERS FLOW CONTROL VALVE POSITION FEEDBACK
NFB010	AI	2	12	6	NFB TO DEGASIFIERS ISOLATION VALVE POSITION FEEDBACK
NFB010	AI	2	13	0	BREAK TANK PUMPS DISCHARGE HEADER PRESSURE
NFB010	AI	2	13	1	NF FEED PUMPS SUCTION HEADER PRESSURE
NFB010	AI	2	13	2	NF BYPASS HEADER PRESSURE
NFB010	AI	2	13	3	NF BYPASS FLOW
NFB010	AI	2	13	4	NFB T0 DEGASIFIERS FLOW
NFB010	AI	2	13	5	BLENDED WATER FLOW
NFB010	AI	2	13	6	NF FEED ORP (PRE-INJECTION)
NFB010	AI	2	13	7	NF FEED ORP (POST-INJECTION)
NFB010	AI	2	14	0	BLENDED WATER pH
NFB010	AI	2	14	1	BLENDED WATER CHLORINE RESIDUAL
NFB010	AI	2	14	2	BLENDED WATER FLUORIDE RESIDUAL
NFB010	AI	2	14	3	BLENDED WATER PHOSPHATE RESIDUAL
NFB010	AI	2	14	4	NF CONCENTRATE CONDUCTIVITY
NFB010	AI	2	14	5	NF CONCENTRATE pH
NFB010	AI	2	14	6	PROCESS ROOM TEMPERATURE
NFB010	AI	2	14	7	ELECTRICAL ROOM TEMPERATURE
NFB010	RTD	3	1	0	NF FEED PUMP 1 MOTOR BEARING TEMP 1
NFB010	RTD	3	1	1	NF FEED PUMP 1 MOTOR BEARING TEMP 2
NFB010	RTD	3	1	2	NF FEED PUMP 2 MOTOR BEARING TEMP 1
NFB010	RTD	3	1	3	NF FEED PUMP 2 MOTOR BEARING TEMP 2
NFB010	RTD	3	1	4	NF FEED PUMP 3 MOTOR BEARING TEMP 1
NFB010	RTD	3	1	5	NF FEED PUMP 3 MOTOR BEARING TEMP 2
NFB010	RTD	3	2	0	NF FEED PUMP 4 MOTOR BEARING TEMP 1
NFB010	RTD	3	2	1	NF FEED PUMP 4 MOTOR BEARING TEMP 2
NFB010	RTD	3	2	2	NF FEED PUMP 5 MOTOR BEARING TEMP 1
NFB010	RTD	3	2	3	NF FEED PUMP 5 MOTOR BEARING TEMP 2
NFB010	RTD	3	2	4	NF FEED PUMP 6 MOTOR BEARING TEMP 1
NFB010	RTD	3	2	5	NF FEED PUMP 6 MOTOR BEARING TEMP 2
NFB010	AO	3	14	0	BREAK TANK PUMP 1 SPEED CMD
NFB010	AO	3	14	1	BREAK TANK PUMP 3 SPEED CMD
NFB010	AO	3	14	2	BREAK TANK PUMP 4 SPEED CMD
NFB010	AO	3	14	3	BREAK TANK PUMP 6 SPEED CMD
NFB010	AO	3	14	4	NF BYPASS FLOW CONTROL VALVE POSITION CMD
NFB010	AO	3	14	5	NFB TO DEGASIFIERS FLOW CONTROL VALVE POSITION CMD
NFB010	AO	3	15	0	NF FEED PUMP 1 SPEED CMD
NFB010	AO	3	15	1	NF FEED PUMP 2 SPEED CMD
NFB010	AO	3	15	2	NF FEED PUMP 3 SPEED CMD
NFB010	AO	3	15	3	NF FEED PUMP 4 SPEED CMD
NFB010	AO	3	15	4	NF FEED PUMP 5 SPEED CMD
NFB010	AO	3	15	5	NF FEED PUMP 6 SPEED CMD

PLC DESIGNATION	MODULE				MODULE / POINT DESCRIPTION
	TYPE	RACK	SLOT	POINT	
NFB010	AO	3	16	0	PHOS FEED PUMP 1 SPEED CMD
NFB010	AO	3	16	1	PHOS FEED PUMP 2 SPEED CMD
NFB010	AO	3	16	2	CAUSTIC SODA FEED PUMP 1 SPEED CMD
NFB010	AO	3	16	3	CAUSTIC SODA FEED PUMP 2 SPEED CMD
NFB010	AO	3	16	4	SODIUM BISULFITE FEED PUMP 1 SPEED CMD
NFB010	AO	3	16	5	SODIUM BISULFITE FEED PUMP 2 SPEED CMD
NFB010	AO	3	16	6	ANTISCALANT FEED PUMP 1 SPEED CMD
NFB010	AO	3	16	7	ANTISCALANT FEED PUMP 2 SPEED CMD
REW010	DI			SPARE	REVIS WELL FIELD ETHERNET SWITCH ALARM
SFW010	DI			SPARE	SOD FARM WELLS ETHERNET SWITCH ALARM

SECTION 40 9513

CONTROL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General:
   1. Drawings and general provisions of Contract.
   2. General and Supplementary Conditions and all Division 1 specification sections.

B. Related Sections of Division 26.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install control panels and consoles in accordance with the Plans and as specified herein.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of the National Electrical Code (NEC) and all other applicable federal, state, and local codes and regulatory requirements.

B. Standards: Materials and workmanship shall conform to the following standards:
   1. National Electrical Manufacturers Association (NEMA).
   2. Institute of Electrical and Electronic Engineers (IEEE).
   3. American National Standards Institute (ANSI).
   4. National Fire Protection Association (NFPA).
   5. Underwriters' Laboratories (UL).
   6. Joint Industrial Council (JIC).
   7. International Society for Measurement and Control (ISA).

C. Qualifications
   1. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of control panels whose products have been in satisfactory use in similar service for not less than 5 years.
   2. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with materials and equipment similar to items specified herein.

1.4 SUBMITTALS

A. General: Furnish manufacturer's product data for enclosures and all components.

B. Materials List: Submit a bill of materials listing quantities, manufacturer's name, and catalog numbers.

C. Wiring Diagrams: Submit wiring diagrams showing all connections for all equipment furnished or installed under this section.
   1. Elementary diagrams shall follow JIC standards.
   2. Instrument loop diagrams shall follow the ISA Standard S5.4.

3. Wire, terminal, and component labeling shall follow established facility conventions where applicable.

D. Shop Drawings: Provide control panel layout drawings which follow JIC standards. Provide shop drawings for each control panel and console as follows:
   1. Dimensional drawings of each enclosure and mounting panel.
   2. Scaled layout drawings identifying name and location of all components and nameplates.
   3. Mounting details including location of anchoring flanges, holes, and data on anchor bolt sizing and load-carrying capacity.
   4. Entry and exit locations of external wiring and conduit and equipment connections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: The Contractor shall store the items furnished under this section until they can be installed. Such storage shall meet the requirements of the manufacturer and be approved by the Owner. Use all means necessary to protect the material of this section before, during, and after installation, and to protect the installed work and materials of all other trades.

PART 2 - PRODUCTS

2.1 ENCLOSURES

A. Enclosure shall be NEMA 4X, unless otherwise specified or shown on the Drawings.
   1. Hinged Door Enclosures: Material of construction shall be fiberglass, 304 stainless steel or as shown on the Drawings.
      a. Manufacturer: Hoffman Enclosures, Inc.; Saginaw Control and Engineering; Stahlin Enclosures; or approved equal.
   2. Fabricated control panel shall be UL508A labeled.

2.2 COMPONENTS

A. As specified in related sections.

B. Miscellaneous Equipment
   1. Slotted plastic wiring ducts with snap-on covers.
   2. Nylon spiral wrap wiring sheaths.
   3. Nylon cable ties with screw anchors.
   4. Nameplates as specified in Division 26. Nomenclature as shown on the Drawings.
   5. Stainless steel screws, fasteners, and miscellaneous hardware, unless otherwise noted.

C. Corrosion Inhibitor Device: Shall be provided for all control enclosures. Provide one (1) unit per 5 cubic feet of volume. Provide one (1) replacement unit for each inhibitor device installed. Devices shall be Hoffman A-HCI 10E or approved equal. Install and date mark while enclosure is in fabricator's shop.

D. Provide thermostatically controlled electric heater in each enclosure for condensation prevention. Heater shall be sized for 40°F temperature rise above ambient, based on enclosure dimensions. Locate heater in compliance with manufacturer recommendations.

E. Surge Protection

1. Provide surge protection for all communication, analog and digital signals which the cable/conductor(s) enter from outside or underground. These signals include, but are not limited to, all 120VAC digital inputs and 24VDC analog inputs.
    a. Surge protection devices shall be type Category C as defined by IEEE C62.41, and consist of a base and a replaceable plug-in surge element.
2. Provide surge protection on all other PLC inputs, PLC outputs, relays and all other instrumentation and control system components as recommended by the manufacturer of each device.
3. Surge protection device shall include a visual indicator for "fault/no protection" indication.
4. Manufacturer: Pheonix Contact, Edco, Thor Systems or approved equal.

F. Power Supplies
1. Provide power supplies as required for the various components and functions of this contract.
2. Required Features:
    a. Provide power for 2-wire transmitter loops using 4-20mAdc current signals.
    b. Input Voltage: 115 VAC.
    c. Output Voltage: 24V to 45V DC, or 12V to 16V DC, as required.
    d. Voltage Regulation: $\pm$ 5 percent.
    e. Fusing: 115 VAC line.
    f. Loop circuits: Suitable for 1 loop circuit only.
    g. Mounting: Suitable for wall mounting inside of panel enclosure.
3. Manufacturers:
    a. Allen-Bradley Bulletin 1606.
    b. Moore Industries.
    c. Or approved equal.

G. Lighting Kit: Provide a 120VAC, fluorescent light fixture inside the enclosure. Fixture shall use 20 watt lamps, minimum. Each light shall include a manual on/off toggle switch and a 120VAC convenience outlet.

H. Uninterruptible Power Supply (UPS).
1. General: Provide a UPS to supply power to the control panel's associated PLC, radio, and internal power supplies during failure of normal power. Maintain battery power to load for 30 minute duration with "no breaks," or interruptions. Upon return of normal ac power, automatically equalize recharge batteries and revert to floating condition.
2. Enclosures: Free standing enclosures sized to house both the batteries and the electronics. DIN rail mounted units may be used when loads/battery time comply with specification requirements.
3. Rectifier/Charger: Solid state rectifiers/charger sized to supply dc power to both the batteries and the static inverter. Equip with automatic shutdown to prevent discharging the batteries completely.
4. Static Inverter: Single phase solid-state static inverter to supply regulated ac output.
5. Batteries: Sealed, maintenance-free lead acid batteries.
6. Detachable line cord and NEMA 5-20R output receptacles.
7. Available Manufacturers: Subject to compliance with requirements, manufacturers offering UPS systems which may be incorporated in the work include, but are not limited to, the following:
    a. APC
    b. Liebert

c. Pheonix Contact

I. Network Access Port
1. For enclosures that include a programmable logic controller (PLC), provide a door mounted GFCI 120VAC duplex power outlet, rated 3A minimum, with front door mounted RJ-45 Ethernet jack connected to the PLC network.
2. Provide a nameplate engraved with “For Programming Use Only”.
3. NEMA 4X rated with hinged cover and securing latch
4. Power external outlet from a dedicated circuit breaker.
5. Provide CAT6 Ethernet cable internally from port to network switch.
6. Manufacturer:
   a. Grace Engineered Products, Inc
   b. Phoenix Contact
   c. Or approved equal

J. Miscellaneous Equipment
1. Slotted plastic wiring ducts with snap-on covers.
2. Nylon spiral wrap wiring sheaths.
3. Nylon cable ties with screw anchors.
4. Nameplates as specified in Division 26 Section “Electrical Identification”, and as shown on the Plans.
5. Stainless steel screws, fasteners, and miscellaneous hardware unless otherwise noted.

2.3 SHOP FABRICATION

A. Fully assemble and test each panel at the factory prior to shipment.
1. Ensure that all wires and cables are securely connected.
2. Ensure all labels and nameplates are easily readable.
3. Perform 100% continuity checks.
4. Provide a temporary power source (120VAC), and check voltage on all applicable circuits, including all 24VDC power supplies.
5. Provide documents and drawings of the completed testing procedures.
6. Complete the fabrication and testing to the satisfaction of the Owner or its designee.
7. Factory Acceptance Test (FAT) – At the discretion of the Owner or its designee, fabricated panels may be subjected to inspection and testing prior to arrival at site. The FAT may be a prerequisite for acceptance. The Contractor shall plan for personnel to arrive at the fabricator’s facility for the FAT. The Contractor shall also allow provisions for a Contractor’s representative and a technician to assist in testing. Temporary power and networking should also be expected as part of the FAT procedure.
   a. A punch list shall be generated by the FAT personnel for any modifications needed prior to shipment to the Owner’s facility. Successful completion of the FAT is a prerequisite for delivery to the Owner’s facility. All FAT punch list items shall be resolved.

B. As a minimum, test all wiring circuits for conductivity and demonstrate that all specified functions can be performed.

C. Identify all components with laminated plastic nameplates.

D. Provide all devices, electrical hardware, wiring, support hardware, fasteners and other components required to make the control enclosures complete and workable units.

E. Estimated Size: Minimum sizes are shown on the Drawings. Contractor shall furnish enclosures of the size and quantity required to house the manufacturers' equipment supplied and all other electrical components installed in the enclosures.

F. Provide stainless steel quick-release latching clamps on three sides of each door and pad-lockable hasp and staple on all panels.

G. All hardware on the enclosures including hinges, pins, clamps, nuts, bolts, washers, screws, etc., shall be stainless steel.

H. Design panels so that conduits and wiring enter and leave through the bottom of the enclosures, unless noted otherwise.

I. Component Arrangement
   1. Group all like components.
   2. Place all internal components on sub-panels.
   3. Arrange all components to allow easy access for connections and service, and to allow removal without affecting other components.
   4. Provide a minimum of 2.5” from device terminals to edge of closest wiring duct.

J. Component Installation
   1. Make all panel cutouts carefully and leave no visible gaps between components and panels.
   2. Mount all components plumb and square.
   3. Attach all components and nameplates with stainless steel machine screws into drilled and tapped holes.
   4. Support and restrain all components to prevent movement.
   5. Attach all relays to mounting strips or rails.

K. Wiring
   1. Route wiring horizontally or vertically.
   2. Protect wiring to door-mounted devices with spiral nylon sheath.
   3. Separate alternating current (ac) and direct current (dc) wiring a minimum of 4 inches. Separate AC and DC buses.
   4. All DC (+) wiring shall be separately fused per device.
   5. Label all wires at each termination with a unique number.
   6. Label each terminal with a unique number.
   7. Terminate all external wiring on terminal blocks.
   8. Terminate all internal wiring on terminal blocks or device terminals. Device neutrals shall not be daisy-chained between devices.
   9. Group all externally powered wiring and terminate on knife disconnect isolating terminal blocks.
   10. Terminate all wiring to devices powered from the control panel on fused terminal blocks.
   11. Fused terminal blocks shall include LED blown fuse indication.
   12. Color code all internal wiring as follows:
      a. Line Voltage ac Power and Control: Black.
      b. AC Control Circuits: Red.
      c. DC Wiring: Blue (positive), Blue with White Stripe (negative).
      d. Externally Powered Wiring: Yellow.
      e. Neutral Conductors: White.
      f. Equipment Grounding Conductors: Green.

13. Route all wiring on sub-panels through plastic wiring ducts with removable covers. Wiring duct shall not be filled over 50%, including spares.
14. Support all wiring to prevent movement or sagging.
15. Secure all cable ties with bolted or screwed mounting plates.
16. Provide a warning sign, placed in a conspicuous location in the interior of the panel, identifying yellow wiring as being powered from an external source and warning that disconnecting power to the panel will not de-energize externally powered wiring.

L. Panel Grounding
1. Provide ground studs factory welded to the enclosure and the enclosure door.
2. Provide tinned copper braided ground strap between enclosure and door.
3. Provide a minimum #8 AWG ground wire from sub-panel to enclosure mounting stud.
4. Ground control power transformer secondary directly to sub-panel immediately adjacent to transformer.
5. Where signal cable shields are to be grounded in the control panel, connect to the equipment ground bus.
6. Connect all DC commons to the low-level isolated dc ground bus.

2.4 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.
1. Quantity: Provide spares for each type listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
a. Control Relay
b. Power Supply
c. Pilot Light
d. Selector Switch
e. Pushbutton
f. Fuses
g. Terminal Block
2. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no additional cost.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices.

B. Examination
1. Verification of Conditions: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Discrepancies: In the event any discrepancies are discovered, immediately notify the Owner's Representative in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

C. Preparation
1. Protection.

a. All equipment and materials shall be packed at the factory to protect each item from damage during shipment and storage.
b. Provide blocking and cushioning materials to prevent damage during shipment.
c. Provide temporary lifting lugs on shipping package as needed.
d. Include approximately 1 pint of touch-up paint for each finish color in shipment.

2. Surface Preparation: The work shall be carefully laid out in advance. Where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary, this work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved, and at no additional cost to the Owner.

D. Application

1. Enclosure, Cabinets, Console Installation.
   a. Locate as shown on the contract drawings. Freestanding enclosures and consoles require an Electrical Equipment Pad provided and installed by this Contractor. Refer to detail on Drawings.
   b. Floor-mounted control panels shall be installed utilizing all stainless steel hardware consisting of concrete anchor and machine bolt assembly.
   c. Wall-mounted panels shall be offset from walls with standoffs. Wall-mounted panels requiring freestanding mounting shall be supported on stainless steel strut with cross bracing and stainless steel hardware.
   d. Seal all conduit entrances watertight.

3.2 FIELD QUALITY CONTROL

A. Tests: Upon completion of all inspections and prior to acceptance by the Owner, perform the field tests outlined in Division 40 Section “Instrumentation – General”.

B. Inspection: Upon completion of this portion of the work, the Contractor shall provide for the services of a qualified representative of the manufacturer to inspect and approve the installation.

END OF SECTION 40 9513

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SECTION 40 9553

NETWORK DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General:
   1. Drawings and general provisions of Contract.
   2. General and Supplementary Conditions and all Division 1 specification sections.

B. Related Sections: Refer to Division 40 9XXX Sections for additional requirements related to this section.

1.2 DESCRIPTION OF WORK

A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to install network switches in accordance with the plans and as specified herein.

B. Types: The types of equipment specified in this section include the following.
   1. Ethernet Switch
   2. Ethernet Media Converter
   3. DIN-rail Fiber Patch Panel

1.3 DEFINITIONS

A. Abbreviations
   1. AHJ. Authority having jurisdiction.
   2. NRTL. Nationally recognized testing laboratory.

1.4 SUBMITTALS

A. General
   1. Comply with the requirements of Division 01 Section “Submittal Procedures”.
   2. Submit information as described below.
   3. Provide all information necessary to determine compliance with the Plans and specifications.

B. Product Data
   1. Manufacturer’s product data sheets, delete or cross out non-applicable information.

C. Quality Control Submittals
   1. Field test reports. Submit certified copies of the field test reports.
   2. Manufacturer’s instructions: Submit manufacturer's current installation instructions.

D. Contract Closeout Submittals: Operation and maintenance (O&M) data

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS – GENERAL

A. General
   1. Provide new and unused products of current manufacture.
   2. Provide products free from defects affecting performance.
   3. All units of the same type shall be from the same manufacturer.

B. Listing and Labeling
   1. Provide UL listed and labeled products.
   2. Products not bearing an NRTL label must be pre-approved in writing by the AHJ.

2.2 ETHERNET SWITCH

A. General: Provide an Ethernet switch for segment connection to the network backbone for area PLCs and operator workstations and as shown on the Drawings.

B. Features
   1. Minimum of (2) send/receive 100Base-FX fiber optic ports
   2. Minimum of (8) 10/100Base-TX (RJ-45) ports
   3. Per-port Status Indicators
      a. Link Integrity
      b. Disabled
      c. Activity
      d. Speed
      e. Half/Full Duplex
   4. Alarm Relay: 1A @ 30VDC
   5. Memory Card
   6. Management console port:
      a. Mini USB cable (driver provided)
   7. Power Requirements: 12-48VDC

C. Performance Requirements:
   1. Support spanning tree protocol
   2. Support ring topology
   3. Switch Management”
      a. Support Simple Network Management Protocol (SNMP)
      b. Bridging Management Information Base
      c. Remote Monitoring (RMON) control
   4. Comply to IEEE 802.3x Full-Duplex on 10Base-T and 100Base-T
   5. Full performance from 32 to 113°F, 5-95% humidity non-condensing

D. Small Form Factor Pluggable Module (SFP):
   1. SFP module shall be provided as integral part of the Ethernet switch to provide connection into fiber optic media as shown on the Drawings.
   2. Support for IEEE 802.3z, 1000BASE-SX standard for 1Gbps data transmission rate.

E. Product Manufacturer and Model
   1. Stratix 5700 Switch, 1783-BMS10CL or equivalent latest compatible series, as manufactured by Allen-Bradley

2.3 ETHERNET MEDIA CONVERTER

A. Description: Converts 10/100Base-T(X) Ethernet media from copper to fiber optic.

B. Features
1. Converts to utilized fiber optic cable type as indicated on the Drawings.
2. (1) 10/100MBit/s RJ45 Port
3. (1) 100MBit/s SC-FX Port
4. Fiber wavelength shall be 1300nm
5. Auto-negotiation
6. Integrated MDI/MDIx changeover
7. Status and diagnostic indicators on device
8. Redundant power supply capable
9. DIN rail mounted
10. Conforms to IEEE 802.3
11. Input power: 24VDC
12. Operating Temperature Range: 32degF – 131degF
13. Humidity: 30-95%, non-condensing

C. Manufacturers: Subject to compliance, provide products manufactured by one of the following:
1. Phoenix Contact
2. Hirschmann
3. Or approved equal.

2.4 DIN-RAIL FIBER PATCH PANEL

A. General: Shall be designed to manage and organize fiber optic cables to and from the equipment or cabling plant.
1. Single panel housing fiber optic enclosure adapted for DIN-rail mounting
2. Protect fiber optic connections for patching or splicing requirements
3. Accommodate up to 12 fibers per enclosure and shall be constructed of steel
4. Include removable covers and pass-through holes
5. Model and Manufacturer:
a. SPH-01P, enclosure by Corning
b. CCH-CP12-15T, adapter plate by Corning

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Conform to manufacturer recommended installation guidelines.
2. Mount the Ethernet switches in enclosures indicated on the Drawings.

B. Physical Network Architecture
1. Physically configure the plant-wide LAN system as shown on the Drawings.
2. Some workstations will be equipped with two network interface cards (NIC) for connection to both networks.
3. IP addresses shall be assigned by Owner for all equipment connected to the plant networks.

3.2 FIELD QUALITY CONTROL

A. Field Test
1. Conduct testing after all connections are made.

2. Test the switches for proper operation by simulating fault conditions at the input terminals of the LAN equipment.
3. Correct any malfunction or error in the designed performance.
4. Check the operation after all LAN equipment has been wired by manually activating the inputs with testing devices that simulate network traffic.

B. Manufacturer Field Services
1. Provide the services of a factory-trained manufacturer representative to configure and start-up equipment specified under this Section.
2. Certify in writing that that the equipment has been installed, configured, and tested in accordance with manufacturer recommendations.

3.3 EXTRA MATERIALS

A. Spare Parts: The Contractor shall provide uninstalled spare parts to the Owner to facilitate proper maintenance and minimize downtime of the PLC system.
1. Quantity: Provide spares for each type listed below equal to 10 percent of the total of each type used in the system rounded up to the next whole number.
a. Ethernet Switch
b. Ethernet Media Converter
c. DIN-rail Fiber Patch Panel
2. Replacements: Any spare part used during the start-up, demonstration, and warranty period shall be replaced by the Contractor at no additional cost.

END OF SECTION 40 9553

SECTION 41 2200

CRANES AND HOISTS

PART 1 - GENERAL

1.1 REFERENCES

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section.

1.2 SCOPE

A. Hoist systems for the NF high pressure feed pumps, as shown on the Contract Drawings.

B. Furnish all professional services, labor, material, equipment, and appurtenances required to provide runway beams and required sway bracing, cranes and hoists complete and operational.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05 1200, Structural Steel Framing.

B. Section 09 9100. Painting.

C. Section 13 3419, Metal Building Systems.

D. Division 26 – Electrical.

1.4 QUALITY ASSURANCES

A. Codes and Standards
1. AGMA, Standards of American Gear Manufacturers Association.
2. AISC, Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
3. American Society for Testing and Materials Specifications
4. ANSI B30.2, Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder).
5. American Welding Society
6. ANSI B30.11, Monorail Systems and Underhung Cranes
7. ANSI B30.16, Standard for Overhead Hoists
8. ASME B30.11, Monorail Systems and Underhung Cranes.
9. CMMA No. 70, Top Running Bridge and Gantry.
10. CMMA No. 74, Top Running and Under Running Electric Overhead Travelling Cranes.
11. Hoist Manufacturers Institute
12. HMI 100, Electric Wire Rope Hoists.
13. HMI 200, Standard Specification for Hand Operated Chain Hoists.
14. HMI 400, Electric Chain Hoist.
15. Monorail Manufacturers Association
16. National Electric Code
17. NEMA, Standards of National Electric Manufacturers Association.

B. Materials: All materials shall be new, and the completed overhead handling system shall be essentially the product of one crane manufacturer regularly engaged in the production of such equipment.

C. Service Class: All equipment shall be designed for minimum "Class C" (Moderate Service) as specified in the ANSI MH27.1 Specifications, and operation in normal ambient temperatures (0 deg to 40 deg C) and normal indoor conditions, free from excessive dust, moisture and corrosive fumes.

D. Vertical Impact: Where powered hoists are used, an impact allowance shall be included in design calculations for carriers (trolleys), cranes, and runways. The impact allowance shall be 1/2% of the rated load for each foot per minute (1.6% of the rated load for each meter per minute) of hoisting speed with a minimum allowance of 15% and a maximum of 50%.

E. Electrical Devices and Equipment: Comply with Division 26 – Electrical, and with Electrical Drawings.

F. Manufacturer's Qualifications: The Manufacturer of Work of this Section shall have 5 years' minimum proven experience in such work and shall have satisfactorily completed 3 jobs of similar size and type within the last 5 years.

G. Professional Engineer:
   1. Engage registered professional engineer legally qualified to practice in the same state as the Site and experienced in providing engineering services of the kind indicated.
   2. Responsibilities include:
      a. Carefully reviewing hoist/monorail system performance and design criteria stated in the Contract Documents.
      b. Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
      c. Preparing or supervising preparation of design calculations and related drawings, Shop Drawings, and a comprehensive engineering analysis verifying compliance of hoist/monorail system runways with requirements of the Contract Documents.
      d. Signing and sealing all calculations and design drawings, and Shop Drawings related to hoist/monorail runway beam design.

H. Manufacturer's Field Representative
   1. Conform to the requirements of Division 01 Section "Quality Control", paragraph 1.7, Manufacturer's Field Services.
   2. The Manufacturer of the Work of this Section shall provide a qualified field representative at the Site. Such field representative shall instruct the Contractor's personnel in the proper handling, installation, start-up, and operation of the equipment and shall instruct the Owner's personnel in the proper start-up, operation, and maintenance of the equipment. The instruction period for the Owner's personnel shall be a minimum of 8 hours.

I. Testing: Each hoist shall be given a shop test, including dynamic loading in accordance with the Manufacturer's test specification and shall comply with the latest edition of ANSI B30.16, Standard for Overhead Hoists.

1.5 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittal Procedures”.

B. Reference Submittals
   1. Installation data, handling and storage instructions.
   2. Maintenance and operating instructions.
   3. Material Certification.
   4. Professional Engineer Certification.
   5. Installer Certification.
   6. Source Quality Control Submittals:
      a. When performed or when required by ENGINEER, submit results of source quality control testing and inspections performed at the mill or shop.
   7. Field Quality Control Submittals:
      a. Load test report, including copy of certifications of test weights.
   8. Manufacturer’s Reports: Submit written report of results of each visit to Site by Manufacturer's Field Representative, including purpose and time of visit, tasks performed, and results obtained.

C. Shop Drawings
   1. Submit for review Shop Drawings showing the following:
      a. Complete description of entire system in sufficient detail to permit item by item comparison with Contract Documents. Layout drawings for all equipment showing installation details, assembly and accessories.
      b. Dimensions and required clearances
      c. Equipment weights
      d. Performance characteristics.
      e. Maximum support reactions.
      f. Specialized wiring diagrams, if applicable.
      g. Deviations from Contract Documents.
   2. Product Data: Include Manufacturer's specifications and installation instructions for each component or product used in the system.

D. Delegated Design Submittals: Submit the following:
   1. Detailed structural design drawings showing details of monorail and support systems, including:
      a. Bracing details.
      b. Member loads and design stresses.
      c. Calculations used for determining member stresses.
      d. Connection details.
      e. Maximum allowable and calculated deflections.
   2. Clearly show dimensions and assumptions on which design is based. Indicate referenced standards and codes. Information shall be project specific.

E. Spare Parts
   1. Spare parts utilized during startup and prior to acceptance of the equipment shall be replaced by the Contractor at no additional cost to the Owner.
   2. Spare parts shall be shipped with the equipment and stored by the Contractor until turned over to the Owner during project closeout.

1.6 HANDLING, DELIVERY, AND STORAGE

A. Handling, delivery, and storage of the Work of this Section shall be in accordance with the Manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE:

A. System Description:
1. Hoists shall conform to headroom, hook elevation, and side clearance requirements shown and indicated in the Contract Documents, and shall provide required available lift height and capacity.

B. Design Criteria:
1. Monorail runway beam:
a. Monorail runway beam, including bracing and attachment to supporting structure, shall conform to AISC Specification for Structural Steel Buildings, and AISC Code of Standard Practice for Steel Buildings and Bridges, and shall conform to Specifications in Division 5, Metals.
b. Monorail track, hangers, supports, plates and connection elements shall conform to ASTM A36 or A572 Grade 50 steel, as required by design.
c. Welding shall conform to AWS D1.1.
d. Bolts shall conform to ASTM A325, with ASTM A563 nuts and ASTM F436 hardened washers. Connections shall conform to the RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
e. Deflection of runway beam under rated load (not including impact) shall not exceed 1/450 of span.
2. Runway Rail Stops:
a. Design to withstand the horizontal load produced by the hoist. Hoist manufacturer shall supply bumpers with sufficient energy absorbing capacity to absorb the horizontal impact load on runway stop.

2.2 HOIST SYSTEMS

A. Schedule

Location	**Capacity**	**Hoist Type**	**Trolley Type**	**Lifting Height**
High Pressure Feed pumps	3.0 ton	Electric	Electric	As shown on Drawings

B. Electric Wire Rope Hoist with Motorized Trolley
1. Manufacturer: ACCO Lifting Products.
2. Max Lift: 15 feet.
3. Lift Speed: 2-speed lift @ 15/5 fpm.
4. Hoist Trolley: Single speed @ 50 fpm with soft start and trolley brake.
5. Power: 460/3/60 with 115 volt controls.
6. Features: Trolley drop down lugs rail sweeps with rubber bumpers, geared limit switch, overload cut off, multiple disc motor brake, mechanical load brake, gravity upper hook ravel limit switch, class F insulation, 30 minute duty motors, NEMA 12 hoist enclosures, drop forged load block with swivel hook and spring latch, helical gearing, stainless steel

ID tags, trolley brake, epoxy painted hoist, thermal overloads, mainline contactor, trolley brake, trolley soft start, 2-part single reeved hoist.

C. Hoist Runway:
1. Provide AISC standard structural steel shapes or manufacturer's standard runways.
Runway shall be installed on the Pre-engineered metal building frame on supports provided by the Pre-engineered metal building manufacturer. Contractor is responsible for providing Pre-engineered metal building manufacturer and design engineer with all support loads required for proper design of the runway beam supports.
Runway shall include end stops at each end. Location as called out on the drawings or as specified during shop drawing review. End stops shall be CMAA designed.

2.3 FINISHING

A. Provide manufacturer's standard shop-applied coating suitable for the service indicated.

B. Surface Preparation and Painting:
1. Surface preparation and shop painting is required for ferrous metals, equipment, and accessories. Do not paint stainless steel and machined surfaces.
2. Clean and apply in the shop prime coat and finish coat in accordance with Division 09, Section "High Performance Coatings".

C. Gears, bearing surfaces, and other machined surfaces shall receive a heavy application of rust-inhibiting coating that shall be maintained during storage and until equipment is placed into operation.

2.4 TOOLS AND SPARE PARTS

A. Supply tools and a spare parts kit for each crane furnished as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

B. Inspect and verify that no part of the building, structure, piping, mechanical systems including ductwork, electrical systems including lighting and conduit, or other elements that will interfere with proper operation of hoist along the entire length of monorail track.

3.2 INSTALLATION

A. General
1. Provision and welding of sway bracing shall be by this Contractor.
2. Comply with Section 05 1200, Structural Steel Framing, for testing and inspection of welds.
3. Coordinate location of runway beam with Pre-Engineered Metal Building manufacturer. Refer to Section 13 3419, Metal Building Systems.

4. Electrical power required for connectors on runway conductor shall be coordinated with the Electrical Contractor prior to roughing-in of conduit.

B. Touch-Up Coating: Touch-up all damaged coating surfaces with compatible coating of identical color in such a manner that there shall be no evidence of damage.

3.3 OPERATION AND DEMONSTRATION

A. The completed installation of the Work of this Section shall be demonstrated to the Owner's personnel. Maintenance and Operation manuals shall be reviewed with the Owner's personnel.

END OF SECTION 41 2200

SECTION 43 1251

COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including, but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this section includes furnishing and installing a plant-wide compressed air system and includes the following.
   1. Air compressor and reviver.
   2. Refrigerated air drier and coalescing filter.
   3. Compressed air piping and fittings.
   4. Compressed air accessories and spare parts.

B. All equipment and piping shall be installed as described herein, as recommended by the equipment manufacturers, and as required in related section including the following:
   1. Division 40 Section “Process Piping”.
   2. Division 40, Section “Process Valves, Gates, and Accessories”.
   3. Division 40, Section “Pipe Supports”.

C. All electrical components shall comply with Division 26.

D. Equipment furnished and installed under this section shall be assembled, erected and placed in proper operating condition in full compliance with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications
   1. The compressor and drier manufacturer shall be the same manufacturer.
   2. All valves and accessories of a similar type (i.e. all ball valves, all hose reels, all quick release couplings, etc.) shall be of the same manufacturer.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01, General Requirements.

B. Product Data
   1. Catalog cut sheets and written description of each item describing its operation.
   2. Construction materials.
   3. Rated capacities of the compressor and drier.
   4. Motor and electrical data.

C. Shop Drawings
   1. Detailed dimensional drawings indicating overall dimensions, elevations, weights, sizes and required clearances.
   2. Diagrams indicating any special maintenance items such as oil compartments and removable accessories.
   3. Anchoring and mounting details.

D. Operation and Maintenance Manual. O&M Manuals shall be in accordance with Division 01, Section "Operation and Maintenance Data".

1.5 SPARE PARTS

A. Spare parts shall be of the same manufacture and quality as those provided with the equipment. Spare parts shall be suitable packaged in accordance with the Manufacturer's recommendations, with labels indicating the contents of each package. Spare parts shall be delivered to the Owner with the equipment of this section.

B. Provide the following spare parts shall be included:
   1. Two (2) compressor motor drive belts.
   2. Two (2) quarts of the manufacturer-recommended compressor oil.
   3. Two (2) 5-micron particulate filter elements.
   4. Two (2) coalescing filter elements.

1.6 HANDLING, DELIVERY, AND STORAGE

A. The compressed air equipment shall be completely factory assembled, aligned, and securely crated for shipment. When received at the site, the equipment shall be stored in its shipping container until ready for installation. The equipment shall be stored in a clean, dry, place, and indoors until ready for installation. Equipment shall not be allowed to freeze.

PART 2 - PRODUCTS

2.1 AIR COMPRESSOR

A. General: The air compressor shall be a dual-motor compressor with a horizontal-oriented receiver tank. The two motors shall be mounted directly to the receiver and the receiver shall be complete with legs to be anchored to a 4-inch thick housekeeping pad.

B. Performance requirements:

1.	Minimum receiver tank capacity:	200 gallons
2.	Number of motors:	2
3.	Maximum motor horsepower:	7.5
4.	Power requirements:	460 volt, 3 phase, 60 hertz.
5.	Minimum air flow at 80 psi:	8.5 CFM

C. Accessories
   1. Provide a duplex motor control panel for operation and alternation of motors, as well as control of the automated blow-down valve and setpoints. Panel shall include a disconnect switch.
   2. Provide OSHA-approved belt guards for each motor.

3. Provide an automatically actuated blow-down valve for programmable operation to drain the receiver tank. Contractor shall install piping from the valve discharge to the nearest floor drain. Valve shall be capable of manual operation in the event of actuator failure. Alternatively, a second drain port with a manual valve can be provided.
4. Receiver shall have an ASME code-rated pressure relief valve.
5. Provide a pressure gauge on the receiver or air discharge line capable of operating over the full range of system pressure.
6. Provide a 5-micron particulate filter and housing on the outlet of the compressor prior to the refrigerated drier.
7. Contractor shall install a 4-inch thick concrete housekeeping pad with dimensions adequate to install the compressor. Provide all necessary stainless steel anchor bolts to affix the compressor to the pad.
8. Provide all necessary adapter fittings and piping to connect the compressor discharge to the particulate filter and air drier.
9. Contractor shall hard-wire the compressor and provide all necessary conduit and disconnects in accordance with Division 26.

D. Manufacturer
1. Quincy.
2. Ingersoll Rand.
3. Puma.
4. Engineer Approved Equal.

2.2 REFRIGERATED AIR DRIER AND COALESCING FILTER

A. General: Provide a refrigerated air drier and coalescing filter housing to provide clean, dry air to the compressed air system.

B. The drier shall be mounted directly onto the compressor by the manufacturer.

C. Mount the coalescing filter housing and accessories directly to the wall with adequate clearances for maintenance and filter replacement. Provide spare filters as specified in “Spare Parts”.

D. Performance requirements: Minimum pressure and air flow capacity shall be equal to or greater than the compressor output capacity.

E. Power Requirements: 120 volt, single phase, 60 Hertz.

F. Accessories
1. Provide all necessary local controls for operation of the refrigerated drier and coalescing filter.
2. Provide an automated drain valve for programmable and periodic draining of the drier. Drain valve shall include a silencer.
3. If shipped lose, the contractor shall install the drier on a 4-inch thick concrete housekeeping pad with dimensions adequate for the equipment footprint. Provide all necessary stainless steel anchor bolts to affix the direr to the pad. The pad may be integral to the compressor pad.
4. Provide all necessary adapter fittings and piping to connect the drier discharge piping to the coalescing filter and the filter to the compressed air system piping.

5. Provide all necessary electrical components for a fully operational system in accordance with division 26.

G. Manufacturer: Shall be the same as the compressor.

2.3 COMPRESSED AIR PIPING

A. Piping: Rigid compressed air piping is specified in Division 40 “Process Piping”.

B. For short-run connections between equipment such as the compressor and drier, use of braided stainless steel flex hose suitable for compressed air is acceptable.

2.4 VALVES AND ACCESSORIES

A. Provides stainless steel ball valves as indicated on the drawings and as required for isolation of piping branches.

B. Valves used for connection to quick release couplings shall be threaded. All other valves used for the compressed air system may be threaded or grooved end suitable for Victaulic connections.

C. Quick release couplings: Provide and install brass locking sleeve quick release couplings with nitrile seals and appropriate inserts for quick connections to ‘loose-shipped’ air hoses. Couplings shall be suitable for 3/8” diameter inserts. Provide at each compressed air drop leg as indicated and the drawings and listed in the accessories in this section.

D. At a minimum, provide the following compressed accessories:
1. Four (4) spare 3/8” diameter quick release couplings.
2. Four (4) spare 3/8” diameter quick release coupling inserts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as shown on the Contract Drawings, approved shop drawings, and as recommended by the Manufacturer. Compressor and drier shall be installed on a concrete housekeeping pad.

B. Add oil to the compressor in accordance to manufacturer’s recommendations.

C. Provide piping to route the discharge of the automatic drains to the nearest floor drain.

3.2 FIELD TESTS

A. After initial startup of the compressor and drier system, a preliminary running-in period will be provided to make field tests and necessary adjustments. The Owner will then operate the compressed air system for a period of fourteen consecutive calendar days.

B. At the end of the specified period of operation, the system will be accepted if, in the opinion of the Engineer, the compressor, drier, and piping and accessories have operated satisfactorily without leaks, excessive vibration, and other operational problems.

END OF SECTION 43 1251

SECTION 43 2100.02

VERTICAL TURBINE PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Provide and test vertical turbine pumps, motors, suction cans, and appurtenances as indicated and in compliance with Contract Documents.

B. All pump wetted parts must be constructed of materials meeting NSF 61.

C. Connections of electrical, control and instrumentation components shall be furnished and installed as specified in divisions 26 and 40 9XXX.

1.2 REFERENCES:

A. ASTM International (ASTM):
1. A36/A36M: Standard Specification for Carbon Structural Steel.
2. A48/A48M: Standard Specification for Gray Iron Castings.
3. A53/A53M: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. A120: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless for Ordinary Uses.
5. A283: Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
6. A395: Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
7. A536: Standard Specification for Ductile Iron Castings.
8. A582: Standard Specification for Free-Machining Stainless Steel Bars
9. A743/A743M: Standard Specification for Castings, Iron-Chromium, Iron-Chromium Nickel, Corrosion Resistant, for General Application.
10. B148: Standard Specification for Aluminum-Bronze Sand Castings
11. D2240: Standard Test Method for Rubber Property – Durometer Hardness.

B. American National Standards Institute (ANSI):
1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

C. American Society of Mechanical Engineers (ASME):
1. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.
2. B16.5: Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

D. American Bearing Manufacturers Association (ABMA):
1. 9: Load Ratings and Fatigue Life for Ball Bearings.
2. 11: Load Ratings and Fatigue Life for Roller Bearings.

E. Hydraulic Institute (HI):
1. Current Standards.

F. NSF International (NSF):
   1. 61: Drinking Water System Components - Health Effects

G. National Electrical Manufacturers Association (NEMA):
   1. MG1: Motors and Generators.

1.3 SUBMITTALS:

A. Submit the following shop drawings in accordance with Division 01, Section "Submittal Procedures":
   1. Data regarding pump and motor characteristics and performance:
      a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, efficiency and NPSH3. Curves shall be provided per HI standards.
         1) For units of same size and type, provide curves for a single unit only.
      b. Provide catalog performance curves at maximum pump speed indicated and specified for each service showing maximum and minimum impeller diameters available, acceptable operating range (AOR) and preferred operating range (POR).
      c. Results of shop performance tests as specified.
      d. Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch (A4) sheets, one curve per sheet.
      e. Listing and value of all internal friction losses for the entire pump assembly.
      f. Shaft power loss
      g. Thrust bearing power loss
   2. Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide NPSH3 curve for each speed.
   3. Shop drawing data for accessory items.
   4. Certified setting plans, with tolerances, for anchor bolts.
   5. Manufacturer's literature as needed to supplement certified data.
   6. Operating and maintenance instructions and parts lists.
   7. Listing of reference installations as specified with contact names and telephone numbers.
   8. Certified results of hydrostatic testing.
   9. Certified results of dynamic balancing.
   10. Bearing temperature operating range for the service conditions specified.
   11. List of recommended spare parts other than those specified.
   12. Shop and field inspection reports.
   13. Bearing Life: Certified by the pump motor manufacturer. Include design data.
   14. Pump shop test results.
   15. Motor shop test results.
   16. Qualifications of field service engineer.
   17. Recommendations for short and long-term storage.
   18. Resonant frequency analysis.
   19. Shop and field testing procedures, pump and piping set up, equipment to be used and ANSI/HI testing tolerances to be followed.
   20. Special tools.
   21. Number of service person-days provided and per diem field service rate.

22. Results of field vibration test data including a vibration signature for each pump and drive assembly. Provide vibration testing procedure for review.
23. Recommended location of discharge pressure gauges.
24. Manufacturer's product data, specifications and color charts for shop painting.
25. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
26. The latest ISO 9001 series certification.
27. Provide a scaled drawing for each pump service showing the pumps and motors including equipment weights, lifting attachments, and clearances for equipment removal and maintenance.
28. Operation and Maintenance Manual. O&M Manuals shall be in accordance with Division 01, Section "Operation and Maintenance Data".

1.4 SPARE PARTS:

A. Comply with the requirements specified in Division 01, Section "Product Requirements".

B. Provide spare parts that are identical to and interchangeable with similar parts installed.
   1. For each pump:
      a. One complete set of gaskets.
      b. One mechanical seal repair kit for each pump provided with mechanical seals.
      c. One set of wearing rings.
   2. For each set of pumps of the same size and performance.
      a. One set of all special tools required.

1.5 QUALITY ASSURANCE:

A. Comply with the requirements specified in Division 01, Section "Quality Control".

B. Pumps shall be the product of one manufacturer.

C. Pumps shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest American Welding Society Code or equivalent.

E. Shop tests as specified.

F. The Contractor shall obtain the pumps, motors, discharge columns, discharge heads, suction cans and appurtenances from the pump manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.
   1. The Contractor shall coordinate the variable frequency motor controllers with the pump and motor manufacturer and submit as part of the shop drawings a written statement signed by the Contractor, pump manufacturer, motor manufacturer and variable frequency motor controller manufacturer that the variable frequency motor controller manufacturer has received the required information from the pump and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also include all motor data and information that has been used for the coordination.

G. Services of Manufacturer's Representative as stated in Division 01, Section "Field Quality Control" and as specified herein.

H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
   1. Service Technician must have a minimum of five (5) years of experience, all within the last seven (7) years, on the type and size of equipment.
   2. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
   3. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:
      a. 2 person-days per treatment facility.
   4. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.
      a. 2 person-days per treatment facility.
   5. Field Performance Testing: Field performance test equipment specified.
      a. 2 person-days per treatment facility.
   6. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
      a. 1 person-days.
   7. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
   8. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

I. Installations will be provided for the size specified as well as similar sizes if less than 5 installations have occurred in the last five (5) years.

J. If equipment proposed is heavier or taller, than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.
   1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

K. For variable speed pump systems the pump manufacturer must perform an analysis of the combined motor and pump assembly for resonant frequency or their harmonics independent of a structure (above ground).
   1. Submit a copy of these calculations for review prior to manufacture or fabrication of any materials.
   2. Should calculations indicate the probability of encountering such frequencies within the speed range required, provide all additional supporting devices necessary to affect the unit mass, and raise or lower resonant point within the speed range required.
   3. Provide and install such additional devices at no additional cost to the Owner.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Division 01, Section "Product Requirements".

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the Process Pump Schedule.

B. Break Tank Pumps: Pump filtered water from the break tank to the NF Bypass and cartridge filters.

C. NF Feed Pumps: Pump cartridge filter effluent to the NF skids.

D. High Service Pumps: Pump finished water to the distribution system.

E. Design Heads:
1. The head requirements indicated are the heads required at the pump's discharge head flange.
2. For wet pit pumps, the pump manufacturer must include all internal losses from the intake bell to the discharge head flange.
3. For pumps installed in a suction can, the pump manufacturer must include all internal losses from the intake of the suction can to the discharge head flange.

F. Coordinate pump dimensions and weights with hoists and bridge cranes as specified in Division 41, Section "Cranes and Hoists" and as indicated.

2.2 MANUFACTURERS:

A. Vertical Turbine Pumps:
1. Floway
2. Flowserve
3. Peerless

2.3 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

2.4 PUMP CONSTRUCTION:

A. Pumps: Vertical turbine pumps, driven as indicated in the Process Pump Schedule.

B. Pump configuration as indicated in the Process Pump Schedule.

C. Rotation: Counterclockwise, viewed from the drive end.

D. Design and proportion all parts of pump for the service specified and indicated.

E. Pumping assemblies, including pump, and motor, to operate within vibration and bearing temperature limits specified over the full operable range of the pump performance.

F. Provide no more than the number of stages as indicated in the Process Pump Schedule to meet the performance specified and indicated.

G. Provide room for inspection, repair and adjustment.

H. Equip pumping assemblies with all specified and required accessories, including lifting attachments.

I. Apply a never seize compound to all bolts.

J. Bowl Assembly:
   1. Pump Bowls: Free from blow-holes, sand holes and all other defects and faults. Bowls to be coated with a NSF 61 coating as specified herein. Provide flanged bowls with Type 316 stainless steel hardware.
   2. Either of the following material options is acceptable:
      a. Cast Iron ASTM A48 Class 30.
      b. Ductile Iron ASTM A395 60-40-18.
   3. Pump Shaft:
      a. ASTM A582, Type 416 Stainless Steel.
   4. Impellers:
      a. Type: Turbine.
      b. Material (either option is acceptable):
         1) Aluminum Bronze ASTM B148, no lead content.
         2) Stainless steel ASTM A743/A743M CF8M.
      c. Provide bowl and impeller wear rings (either option is acceptable):
         1) Aluminum Bronze ASTM B148 bowl and impeller wear rings, no lead content.
         2) Stainless steel ASTM A743/A43M CA-40 bowl and impeller wear rings.
      d. Provide the impellers secured to the shaft with a tapered lock bushing for shafting 2-3/16 inches (56 mm) and smaller and thrust washer, key and snap ring for shafting larger than 2-3/16 inches (56 mm).
      e. Dynamically balance impellers.
   5. Suction Bell with flared inlet (either option is acceptable):
      a. ASTM A48 Class 30 cast iron
      b. Ductile Iron ASTM A395 60-40-18.
   6. Suction Bell Bearing:
      a. Copper Bismuth Alloy, Federalloy® or equal.
      b. Provide a sand collar of Copper Bismuth Alloy, Federalloy or equal, attached to shaft with a Type 316 stainless steel set screw arrangement.
      c. Provide a suction bowl plug or cap of cast iron.
   7. Intermediate Bowl Bearings:
      a. Copper Bismuth Alloy, Federalloy or equal.
   8. Discharge Bowl and Connector Bearings:
      a. Provide bearings of bronze Copper Bismuth Alloy, Federalloy or equal.
   9. Discharge Bowl:
      a. Provide a flanged discharge bowl of ASTM A48 Class 30 cast iron.

K. Discharge Head:

1. Provide size and configuration as indicated in the Process Pump Schedule.
2. Material:
    a. ASTM A120, A53/A53M and A283 Grade D steel.
        1) Provide a minimum of four (4) supports at maximum of 90 degree spacing from baseplate to motor flange for all variable speed applications (this requirement may be negated or modified as a result of the FEA/lateral and torsional analysis).
3. Provide integral flange for bolting to column flange.
4. Provide a foundation plate of cast iron ASTM A48/A48M Class 30 or fabricated steel ASTM A36.
5. Connection:
    a. Flanged: ANSI/ASME 16.5, 150-lb.
6. Provide pump head and baseplate designed to withstand all thrust conditions imposed by the pump and driver during operation at the specified and indicated conditions and at future conditions specified and indicated.
7. Provide pumps with vertical solid shaft (VSS) motors with spacer type couplings.
8. Pumps with a separate thrust bearing arrangement are not acceptable.
9. Provide neoprene gasket between top column flange and discharge head.
10. Provide a plugged pre-lubrication connection with a Type 316 stainless steel plug.
11. Provide a minimum 3/4-inch NPT drain connection.
12. Provide Type 316 stainless steel guard and hardware.

L. Column and Shafting:
1. Type: Flanged with Open Line shaft and Type 316 stainless steel bolts and nuts.
    a. Size: As indicated in the Process Pump Schedule.
2. Material: Steel ASTM A53 Grade B.
    a. Provide section lengths as indicated, but no longer than 10 feet-0 inches (3000 mm). Provide number of sections to allow pump to be removed within space indicated.
3. Provide pipe thickness in accordance with AWWA standard wall pipe.
4. Line shaft and couplings: AISI stainless steel (minimum 410 SST).
5. Bearing retainer: Copper Bismuth Alloy, Federalloy, Copper Bismuth C89835, Engineer Approved Equal.
6. Bearing: Copper Bismuth Alloy, Federalloy, or Engineer Approved Equal.
7. Connector Bearing: Bronze Copper Bismuth Alloy, Federalloy, or Engineer Approved Equal.
8. Hardware: Type 316 stainless steel.
9. Transition: Provide a tapered transition where size of discharge bowl and column are not the same.
10. For pumps without suction cans, provide lifting lugs with lifting eyes 180 degrees apart below each column flanged connection for pump removal.

2.5 MECHANICAL SEALS:

A. Provide stuffing box with split mechanical seal
1. Manufacturer: Chesterton Style 442, Flex-a-Seal style 85, or Engineer Approved Equal
2. Materials:
    a. Gland: Type 316 stainless steel.
    b. Rotary Holder: Type 316 stainless steel.
    c. Hardware: Type 316 stainless steel.

d. Springs: Hastelloy C or Elgiloy
e. Rotating Faces: Silicon Carbide.
f. Stationary Faces: Silicon Carbide.
g. Elastomers: Viton
h. Restriction Bushing: Split type, glass filled teflon.

3. Seals will be installed in the pumps at the jobsite by the seal manufacturer's field service technician.

B. Provide a NPT water flush connection – minimum 3/8 inch.

2.6 PUMP SUCTION CAN:

A. Type:
1. Above grade suction:
a. Connection:
1) Flanged: ANSI/ASMB B16.5 Class 150.
2. Below ground suction:
a. Connections:
1) Flanged: ANSI/ASME B16.5 Class 150.
2) Provide a vent for each can.
3. Can Diameter: As indicated in the Process Pump Schedule.
4. Suction Size: As indicated in the Process Pump Schedule.
5. Provide vanes at the bottom and sides of the can in accordance with ANSI/HI 9.8
6. Provide can wall thickness designed for a test pressure of 1.50 times the maximum suction pressure indicated.
7. Provide a can vent, minimum 1 inch (25 mm) or as required by the pump manufacturer.
8. Provide drain/flushing connection at bottom of can as indicated.

B. Material:
1. 304 or 316 SST.

2.7 MOTORS:

A. Provide in accordance with Division 26, Section "Polyphase Integral Horsepower Motors" and as specified and indicated.

B. Horsepower rating of motors: Not less than maximum brake horsepower requirements of pumps under any point on the pump curve (without operating in the motor service factor).

C. Motor enclosure and motor speed: As indicated in the Process Pump Schedule.

D. Provide motors with base supports with machined registered joints for mounting on pump discharge head.

E. Provide vertical solid shaft (VSS) motors and non-reverse ratchets.

F. Non Reverse Ratchets:
1. Ball type only.
2. Size for a minimum of 200 percent of the full motor torque.

G. In addition to the requirements for bearings specified under Electric Motors in Division 26, Section "Polyphase Integral Horsepower Motors", provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

H. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet (1 metre) from motor.

I. Operate without overheating at the speeds specified and indicated.

J. Service Factor: 1.15, with 1.0 inverter duty rating for pumps equipped with variable frequency motor controllers.

K. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

L. Rating: 460V, 3-phase, 60 Hertz.

M. Insulation: Class F with Class B temperature rise, 40 degrees C ambient.

N. Site Altitude: Less than 3,300 feet (1000 metres) above sea level.

O. Motors shall be provided with over-temperature switches in the windings. Switch action shall be as shown on the drawings.

2.8 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces and interior of column and discharge head, NSF 61 high solids epoxy in accordance with Division 09, Section "High Performance Coatings."

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.9 SHOP TESTING:

A. Provide motor shop testing in accordance with Division 26, Section "Polyphase Integral Horsepower Motors".

B. Pump Tests:
   1. Test pump bowls, column and discharge head under a hydrostatic head of at least 75 psi (500 kPa) or 150 percent of rated shutoff head, whichever is greater. Test pump assembled.
   2. Certified performance Testing.
      a. Run pump at full speed rating point for 60 minutes prior to start of any testing.
      b. Full speed tests:

1) Test pumps at the conditions specified and indicated and take not less than seven operating points between shut-off and run out. Test points must be at the conditions specified and indicated.
2) Take readings to determine flow, differential pressure, rpm, horsepower, and efficiency.
3) Operate each pump for not less than one hour and take readings to determine that the pump will operate as specified and indicated without cavitation at the specified minimum head condition with not more than the specified NPSH available. Test with the job submergence as indicated.

c. Variable speed tests:
1) Conduct tests as specified above for full speed at reduced speeds except that tests for cavitation at run out are not required.
2) Run one speed test at speed required to discharge the minimum rating point specified and indicated with one point of test at the minimum rating point.
3) Run a second test at a speed approximately midway between full and minimum speed.
4) Run addition tests for each reduced speed operating condition specified and indicated.

d. Factory tests on pumps:
e. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.

3. Run all tests in accordance with the latest standards of the Hydraulic Institute and as specified.
4. Testing Acceptance Grade and Tolerances:
a. ANSI/HI 14.6 Acceptance Grade: 1U.
b. Efficiency Tolerance: -0 percent.
c. If pumps do not meet the tolerances specified, trim the impeller and retest until the specified results are obtained.
5. In the event that specified tests indicate that pump or motor will not meet specifications, Engineer has the right to require additional complete witnessed tests for all pumps and motors at no additional cost to the Owner.
6. Repeat tests until specified results are obtained.
7. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

2.10 VIBRATION AND TEMPERATURE MONITORING

A. General:
1. Manufacturer shall provide pump/motor vibration/temperature motoring as specified.

B. Vibration Monitoring
1. Pump vibration shall be monitored using velocity sensors.
2. Number of Sensors: Two (2) per Pump
3. Location: Per pump manufacturer, 90 degree offset between sensors.
4. Manufacturer Make/Model: Allen Bradley Model EK-48958

C. Temperature Monitoring
1. Motor bearing temperatures shall be monitored using resistance temperature detectors (RTDs).
2. Provide 100 ohm, 3-wire, platinum, RTDs prewired to NEMA 4X terminal box mounted on motor base.
3. Number of Sensors: Two (2) per Pump

4. Location: Motor bearings.

2.11 CONTROLS

A. Control components, where specified within this section, shall be provided under this section.

B. The equipment specified under this section shall operate manually/automatically as shown on the drawings and specified in sections 40 9XXX. Any additional materials of equipment required by this section's manufacturer, but not shown on the drawings or specified in sections 40 9XXX, to allow this equipment to function in the required manner, shall be furnished and installed under this section.

C. Provide all miscellaneous supports, brackets, fasteners, and fabrications required to mount and install equipment controls provided under this section.

PART 3 - EXECUTION

3.2 INSTALLATION:

A. Install items in accordance with shop drawings, manufacturer's printed instructions and as indicated.

B. Install pumping units on a concrete pad and align thereon.
1. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.

C. After alignment is correct, grout using high grade non-shrink grout.
1. Do not imbed leveling nuts in grout.

D. All electrical power and control connections shall be furnished under division 26.

3.3 FIELD TESTING:

A. Test piping connections to prove the pump nozzle are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles. This must be performed and the piping acceptable prior to any field performance testing.

B. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 01 for checklist.

C. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each pump in presence of the Engineer determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.
1. During tests, observe and record head, capacity, pump bearing housings and motor bearing temperature, noise and vibration and motor inputs.
a. Provide vibration signature test data for each pump and drive assembly.
1) Limit: Within ANSI/HI Standards.

b. Bearing Temperature: Bearing temperature not to exceed 180 degrees F (82 degrees C).
c. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.

2. Run each pump for minimum four hours prior to taking temperature readings of the pumps, motors, and shafting.
3. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
4. Repeat tests until specified results are obtained.
5. Contractor to provide all water labor, piping, equipment, flow meters and test gauges for conducting tests.
   a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all pumping systems even in those cases where permanent flow meters are installed.
   b. All calibrations must be within 30 days of the field testing.
   c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.
   d. Contractor is responsible for delivery and disposal of water used for testing.

D. Make all adjustments necessary to place equipment in specified working order at time of above tests.

E. Test pump on product only. If product is not available, test with water. Water for testing furnished by Contractor.

F. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted.

3.4 FIELD TOUCH-UP PAINTING

A. After installation and testing, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.5 CONTRACT CLOSEOUT:

A. Provide in accordance with Division 01, Section “Closeout Procedures”.

END OF SECTION 43 2100.02

RARWTP PUMP SCHEDULE

A. NF Feed Pumps

1.	Tag Nos:	NFFP-1, 2, 3, 4, 5, 6
2.	Number of Units:	Six (6)
3.	Location:	NF Building
4.	Capacity:	1,288 gpm
5.	Head:	370 feet
6.	Minimum Shutoff Head:	430 feet
7.	Minimum Overall Efficiency:	80%
8.	Constant Speed or VFD:	VFD
9.	Minimum Suction Size:	12-inch
10.	Minimum Discharge Size:	10-inch
11.	Max Pump Speed:	1,185 rpm
12.	Max Motor Size:	200 hp
13.	Max Motor Speed:	1,200 rpm
14.	Motor Enclosure Type:	TEFC
15.	Drive Type:	Direct
16.	Notes:	Pumps installed in suction cans.
17.	Can Diameter:	20-inch

B. High Service Pumps

1.	Tag Nos:	HSP-5
2.	Number of Units:	One (1)
3.	Location:	High Service Pump Building
4.	Capacity:	2,475 gpm
5.	Head:	240 feet
6.	Minimum Shutoff Head:	330 feet
7.	Minimum Overall Efficiency:	77%
8.	Constant Speed or VFD:	VFD
9.	Minimum Suction Size:	N/A
10.	Minimum Discharge Size:	14-inch
11.	Max Pump Speed:	1,770 rpm
12.	Motor Size:	250 hp
13.	Max Motor Speed:	1,800 rpm
14.	Motor Enclosure Type:	TEFC
15.	Drive Type:	Direct
16.	Notes:	Suction can is existing and already installed.
17.	Can Diameter:	20-inch

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SECTION 43 2100.23

END SUCTION CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Provide and test process pumps, motors, drives, and appurtenances as indicated and in compliance with Contract Documents.

B. Connections of electrical, control and instrumentation components shall be furnished and installed as specified in divisions 26 and 40 9XXX.

1.2 REFERENCES:

A. American Bearing Manufacturers Association (ABMA):
   1. 9: Load Ratings and Fatigue Life for Ball Bearings.
   2. 11: Load Ratings and Fatigue Life for Roller Bearings.

B. American National Standards Institute (ANSI):
   1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

C. ASTM International (ASTM):
   1. A36/A36M: Standard Specification for Carbon Structural Steel.
   2. A48/A48M: Standard Specification for Gray Iron Castings.
   3. A108: Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
   4. B584: Standard Specification for Copper Alloy Sand Castings for General Applications

D. Hydraulic Institute (HI):
   1. Current Standards.
   2. 14.6: Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

E. National Electrical Manufacturers Association (NEMA):
   1. MG1: Motors and Generators.

1.3 SUBMITTALS:

A. Submit the following shop drawings in accordance with Division 01, Section “Submittal Procedures”:
   1. Data regarding pump and motor characteristics and performance:
      a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, efficiency and NPSHr.
         1) For units of same size and type, provide curves for a single unit only.
      b. Provide catalog performance curves at maximum pump speed indicated and specified for each service showing maximum and minimum impeller diameters available, acceptable operating range (AOR) and preferred operating range (POR).
      c. Results of shop performance tests as specified.

d. Submit curves for guaranteed performance, and shop performance tests, one curve per sheet.

2. Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide $NPSH_r$ curve for each speed.
3. Shop drawing data for accessory items.
4. Certified setting plans, with tolerances, for anchor bolts.
5. Manufacturer's literature as needed to supplement certified data.
6. Operating and maintenance instructions and parts lists.
7. Listing of reference installations as specified with contact names and telephone numbers.
8. Certified results of hydrostatic testing.
9. Certified results of dynamic balancing.
10. Bearing temperature operating range for the service conditions specified.
11. List of recommended spare parts other than those specified.
12. Shop and field inspection reports.
13. Bearing Life: Certified by the pump manufacturer. Include design data.
14. Pump shop test results.
15. Motor shop test results.
16. Qualifications of field service engineer.
17. Recommendations for short and long-term storage.
18. Shop and field testing procedures, pump and piping set up, equipment to be used and ANSI/HI testing tolerances to be followed.
19. Special tools.
20. Number of service person-days provided and per diem field service rate.
21. Results of field vibration test data including a vibration signature for each pump and drive assembly. Provide vibration testing procedure for review.
22. Recommended location of suction and discharge pressure gauges.
23. Manufacturer’s product data, specifications and color charts for shop painting.
24. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
25. The latest ISO 9001 series certification.
26. Operation and Maintenance Manual. O&M Manuals shall be in accordance with Division 01, Section “Operation and Maintenance Data”.

1.4 SPARE PARTS:

A. Comply with the requirements specified in Division 01, Section “Product Requirements”.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.
1. For each pump:
   a. One complete set of gaskets and O-rings.
   b. Three complete sets of packing. Including lantern ring for each pump provided with packing.
   c. One mechanical seal repair kit and restriction brushing or spare mechanical seal for each pump provided with mechanical seals.
   d. One shaft sleeve.
2. For each set of pumps of the same size and performance.
   a. One set of all special tools required.

1.5 QUALITY ASSURANCE:

A. Comply with the requirements specified in Division 01, Section “Quality Control”.

B. Pumps of the same type shall be the product of one manufacturer.

C. Pumps shall be manufacturer’s standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.

E. Shop tests as specified.

F. The Contractor shall obtain the pumps, motors, and appurtenances from the pump manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.
   1. The Contractor shall coordinate the variable frequency motor controllers with the pump and motor manufacturer and submit as part of the shop drawings a written statement signed by the Contractor, pump manufacturer, motor manufacturer and variable frequency motor controller manufacturer that the variable frequency motor controller manufacturer has received the required information from the pump and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also include all motor data and information that has been used for the coordination.

G. Services of Manufacturer's Representative as stated in Division 01, Section “Product Requirements” and as specified herein.

H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
   1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
   2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:
      a. 1 person-days per treatment facility.
   3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.
      a. 1 person-days per treatment facility.
   4. Performance Testing: Field performance test equipment specified.
      a. 1 person-days per treatment facility.
   5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
      a. 1 person-days.
   6. Credit to the Owner, all unused service person-days specified above, at the manufacturer’s published field service rate.
   7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

I. Manufacturer of pumps shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Division 01, Section “Product Requirements”.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the Pump Schedule.

B. Pumps normally operate with a flooded suction except that pumps will be subject to a suction lift if indicated in the Process Pump Schedule.

2.2 END SUCTION CENTRIFUGAL PUMPS:

A. Manufacturers:
1. Flowserve
2. Sulzer

B. Type: Non-overloading, single stage volute centrifugal pumps. Direct coupled to motor.
1. Key seated, provide Type 316 stainless steel lock nuts.

C. Materials Configuration No. 1:
1. Casing, Bearing Frame and Seal Plate:
   a. Ductile Iron ASTM A395 60-40-18.
2. Impeller, enclosed or semi open, dynamically balanced (either option is acceptable):
   a. Ductile Iron ASTM A 395 60-40-18.
   b. Type 316L SST.
   c. Duplex SST CD6MN ASTM A890A.
3. Shaft (either option is acceptable):
   a. Type 316 stainless steel.
   b. Duplex SST AISI 329.
4. Sleeves (either option is acceptable):
   a. Type 316 stainless steel.
   b. Duplex SST AISI 329.

D. Materials Configuration No. 2:
1. Casing, Bearing Frame and Seal Plate (either option is acceptable):
   a. Type 316L SST.
   b. Duplex SST CD6NM ASTM A890A.
2. Impeller, enclosed or semi open, dynamically balanced (either option is acceptable):
   a. Type 316L stainless steel.
   b. Duplex SST CD6MN ASTM A890A.
3. Shaft (either option is acceptable):

a. Type 316 SST.
b. Duplex SST AISI 329.

4. Sleeves (either option is acceptable):
   a. Type 316 stainless steel.
   b. Duplex SST AISI 329.

E. Bearing: Grease lubricated ball bearings.

F. Mechanical Seals: Provide as specified herein.

G. Motors: Provide as specified herein.

H. Couplings: Provide as specified herein.

I. Baseplates: Provide as specified herein.

2.3 PUMP CONSTRUCTION – GENERAL:

A. Design and proportion all parts of pump specially adapted for the service specified and indicated.

B. Pump Mounting:
   1. Horizontal Pumps:
      a. Mount each pump and drive on a common baseplate.
         1) Material: ASTM A36/A36M fabricated structural steel.
         2) Provide structural steel shape bases for pumps 4-inch (100 mm) and larger and bent form bases for pumps smaller than 4-inch (100 mm) unless otherwise specified.
         3) Provide bases with provisions for grouting and for anchor bolts.
         4) Design baseplates to support pump and driver.
         5) Provide planed surfaces of bearing pads for pumps and drives.

C. Design casings for removal of rotating parts without disconnecting suction and/or discharge piping.

D. Provide lifting devices on pump casings for handling.

E. Provide ribs or reinforcing required to withstand the specified hydrostatic test pressure, to prevent deflection caused by hydraulic thrust and to support the motor.

F. Provide components with machined registered concentric shoulder fits for precision alignment. Equipment without registered fits is not acceptable.

G. Seals:
   1. Provide split mechanical seals for all direct coupled pumps unless otherwise specified.
   2. Pump seals shall not require seal water.
   3. Mechanical seal:
      a. Materials:
         1) Gland: Type 316 stainless steel.
         2) Rotary Holder: Type 316 stainless steel.
         3) Hardware: Type 316 stainless steel.

4) Springs: Hastelloy C or Elgiloy.
5) Rotating Faces: Silicon Carbide.
6) Stationary Faces: Silicon Carbide.
7) Elastomers: Viton.
8) Restriction Bushing: Split type, glass filled teflon.

b. Provide Enviroseal Spiraltrac bushing version D, type A.
1) For vertically mounted pumps provide seal vent as indicated and in accordance with API Plan 13.

H. Couplings:
1. Non lubricated, polyurethane flex material type.
2. Split design.
3. Spacer type.
4. Manufacturer: Rexnord Omega, TB Woods SEC-series, or Engineer Approved Equal.
5. Provide guards for protection for personnel, conforming to OSHA requirements.

2.4 MOTORS:

A. Provide in accordance with Division 26, Section "Polyphase Integral Horsepower Motors" and as specified and indicated.

B. Horsepower rating of motors: Not less than maximum brake horsepower requirements of pumps under any condition of operation specified and indicated without operating in the motor service factor.

C. Motor enclosure and motor speed: As indicated in the Process Pump Schedule.

D. Provide motors for horizontal pumps with mounts for bolting to baseplate.

E. In addition to the requirements for bearings specified under Electric Motors in Division 26, Section "Polyphase Integral Horsepower Motors", provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

F. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet from motor.

G. Operate without overheating at the speeds specified and indicated.

H. Service Factor: 1.15, with 1.0 inverter duty rating for pumps equipped with variable frequency motor controllers.

I. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

J. Rating: 460V, 3-phase, 60 Hertz.

K. Insulation: Class F with Class B temperature rise, 40 degree C ambient.

L. Site Altitude: Less than 3,300 feet above sea level.

M. Provide Inpro/Seal bearing isolators.

N. Motors shall be provided with over-temperature switches in the windings. Switch action shall be as shown on the drawings.

2.5 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Division 09, Section "High Performance Coatings".

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.6 SHOP TESTING:

A. Provide in accordance with Division 01, Section "Starting and Adjusting".

B. Provide motor shop testing in accordance with Division 26, Section "Polyphase Integral Horsepower Motors".

C. Pump Tests:
1. Test pump casings under a hydrostatic head of at least 75 psi or 150 percent of rated shutoff head, whichever is greater.
2. Provide certified performance tests as specified herein for all pumps
3. Certified performance testing.
   a. Run pump at full speed rating point for 60 minutes prior to start of any testing.
   b. Full speed tests:
      1) Test pumps at the conditions specified and indicated and take not less than seven operating points between shut-off and run out. Test points must be at the conditions specified and indicated.
      2) Take readings to determine flow, differential pressure, rpm, horsepower, and efficiency.
      3) Operate each pump for not less than one hour and take readings to determine that the pump will operate as specified and indicated without cavitation at the specified minimum head condition with not more than the specified NPSH available. Test with the job submergence as indicated.
   c. Variable speed tests:
      1) Conduct tests as specified above for full speed at reduced speeds except that tests for cavitation at run out are not required.
      2) Run one speed test at speed required to discharge the minimum rating point specified and indicated with one point of test at the minimum rating point.
      3) Run a second test at a speed approximately midway between full and minimum speed.
      4) Run addition tests for each reduced speed operating condition specified and indicated.
   d. Factory tests on pumps:
      1) Use tested job motors that are shipped to the pump testing facility for use in the pump tests.

2) Use factory test motors.
3) Use factory calibrated test drives.

e. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.

4. Run all tests in accordance with the latest standards of the Hydraulic Institute and as specified.
5. Testing Acceptance Grade and Tolerances:
   a. ANSI/HI 14.6 Acceptance Grade: 1E.
   b. If pumps do not meet the tolerances specified, trim the impeller and retest until the specified results are obtained.
6. In the event that specified tests indicate that pump or motor will not meet specifications, Engineer has the right to require additional complete tests for all pumps and motors at no additional cost to the Owner.
7. Repeat tests until specified results are obtained.
8. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

2.7 CONTROLS

A. Control components, where specified within this section, shall be provided under this section.

B. The equipment specified under this section shall operate manually/automatically as shown on the drawings and specified in sections 40 9XXX. Any additional materials of equipment required by this section's manufacturer, but not shown on the drawings or specified in sections 40 9XXX, to allow this equipment to function in the required manner, shall be furnished and installed under this section.

C. Provide all miscellaneous supports, brackets, fasteners, and fabrications required to mount and install equipment controls provided under this section.

PART 3 - EXECUTION

3.2 INSTALLATION:

A. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.

B. Install pumping units on a concrete pad and align thereon.
   1. Coupling halves must be disconnected and only reconnected after alignment.
   2. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.

C. Horizontal pumps: Dowel pump and drive to baseplate after alignment in field to facilitate realignment after disassembly.

D. Final Coupling Alignment:
   1. Perform only after base is installed and piping is connected and pump nozzle connections tested in accordance with paragraph 3.2.
   2. If realignment is required piping must be disconnected prior to alignment, piping reconnected and alignment checked prior to connecting coupling halves.

E. After alignment is correct, grout using high grade non-shrink grout.

1. For horizontal pumps fill entire base and leave no gaps or voids.
2. Do not imbed leveling nuts in grout.

F. All electrical power and control connections shall be furnished under division 26.

3.3 FIELD TESTING:

A. Test piping connections to prove the pump nozzle are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles. This must be performed and the piping acceptable prior to any field performance testing.

B. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 01 for checklist.

C. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each pump in presence of the Engineer to determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.
   1. During tests, observe and record head, capacity, pump bearing housings and motor bearing temperature, noise and vibration and motor inputs.
      a. Provide vibration signature test data for each pump and drive assembly.
         1) Limit: 100 percent of ANSI/HI allowable limits.
      b. Bearing Temperature: Bearing temperature not to exceed 180 degrees F (82 degrees C).
      c. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.
   2. Run each pump for minimum four hours prior to taking temperature readings of the pumps, motors, and shafting.
   3. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
   4. Repeat tests until specified results are obtained.
   5. Contractor to provide all water labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.
      a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all pumping systems even in those cases where permanent flow meters are installed.
      b. All calibrations must be within 30 days of the field testing.
      c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.
      d. Contractor is responsible for delivery and disposal of water used for testing.

D. Make all adjustments necessary to place equipment in specified working order at time of above tests.

E. Test pump on product only. If product is not available, test with water. Water for testing furnished by Contractor.

F. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the

Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

3.4 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.5 CONTRACT CLOSEOUT:

A. Provide in accordance with Division 01, Section “Closeout Procedures”.

END OF SECTION 43 2100.23

RARWTP PUMP SCHEDULE

A. Break Tank Pumps

1.	Tag Nos:	BTP-1, 3, 4, 6 (BTP-2 and 5 are future)
2.	Number of Units:	Four (4)
3.	Location:	NF Building
4.	Material Coniguration:	No. 1
5.	Capacity:	3,756 gpm
6.	Head:	93 feet
7.	Minimum Shutoff Head:	120 feet
8.	Minimum Efficiency:	80%
9.	Constant Speed or VFD:	VFD
10.	Minimum Suction Size:	N/A
11.	Minimum Discharge Size:	10-inch
12.	Max Pump Speed:	1,180 rpm
13.	Max Motor Size:	125 hp
14.	Max Motor Speed:	1,200 rpm
15.	Motor Enclosure Type:	TEFC
16.	Drive Type:	Direct

B. Membrane Cleaning System Pumps

1.	Tag Nos:	MCSP-1, 2
2.	Number of Units:	Two (2)
3.	Location:	NF Building
4.	Material Coniguration:	No. 2
5.	Capacity:	1,080 gpm
6.	Head:	127 feet
7.	Minimum Shutoff Head:	145 feet
8.	Minimum Efficiency:	75%
9.	Constant Speed or VFD:	VFD
10.	Minimum Suction Size:	6-inch
11.	Minimum Discharge Size:	4-inch
12.	Max Pump Speed:	1,770 rpm
13.	Max Motor Size:	60 hp
14.	Max Motor Speed:	1,800 rpm
15.	Motor Enclosure Type:	TEFC
16.	Drive Type:	Direct

SECTION 43 2121

CHEMICAL TRANSFER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor shall provide transfer pumps for the chemical(s) as listed in this Specification.

C. Connections of electrical, control and instrumentation components shall be furnished and installed as specified in divisions 26 and 40 9XXX.

1.2 QUALITY ASSURANCE

A. Pump shall be a product of a manufacturer regularly engaged in the production of such equipment for not less than the past 5 years.

B. The equipment manufacturer shall provide a full warranty for a period of one (1) year after plant start-up.

1.3 SUBMITTALS

A. Provide technical submittals in accordance with Division 01 Section “Submittal Procedures”, demonstrating that all equipment provided conforms completely to the requirements of this Section.

B. Product Data
1. Catalog cut sheets and description of all items.
2. Materials of construction.

C. Operation and Maintenance Manual.
1. O&M Manuals shall be in accordance with Division 01, Section “Operation and Maintenance Data”.

1.4 SPARE PARTS
1. For each size pump provided, provide one (1) shelf spare pump.

1.5 HANDLING, DELIVERY AND STORAGE

A. Handling and storage instructions shall accompany equipment delivered to the site. Store all equipment.

PART 2 - PRODUCTS

2.1 PUMP

A. General: Pumps shall be a seal-less magnetic drive unit with isolated housing container and suitable for the chemical being pumped. Chemical shall be pumped without direct connection with the motor. Pump shall be suitable for the application as identified in the pump schedule.

B. Design:
   1. Mounting Configuration: Horizontal, close coupled
   2. Pump Casing: Ductile iron with PTFE chemically resistant lining.
   3. Impeller: single piece closed impeller.
   4. Shaft, Bushings, and Thrust Ring: Silicone Carbide.

C. Motor
   1. NEMA C-face.
   2. Motor Speed: 1800 rpm.
   3. Electrical Characteristics: 460V, 3-Phase, 60 Hz.
   4. Motors shall be provided with over-temperature switches in the windings. Switch action shall be as shown on the drawings.

D. Design
   1. Separate magnetic drive assembly.
   2. Suitable for chemicals with properties as identified in the Pump Schedule.
   3. Self Priming.
   4. Ceramic bushings.

E. Manufacturer:
   1. ANSIMAG, KM Series.

2.2 CONTROLS

A. Control components, where specified within this section, shall be provided under this section.

B. The equipment specified under this section shall operate manually/automatically as shown on the drawings and specified in sections 40 9XXX. Any additional materials of equipment required by this section's manufacturer, but not shown on the drawings or specified in sections 40 9XXX, to allow this equipment to function in the required manner, shall be furnished and installed under this section.

C. Provide all miscellaneous supports, brackets, fasteners, and fabrications required to mount and install equipment controls provided under this section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be complete and in accordance with the Drawings and Manufacturer's recommendations.

B. All electrical power and control connections shall be furnished under division 26.

END OF SECTION 43 2121

RARWTP TRANSFER PUMP SCHEDULE

A. Sodium Bisulfite ($NaHSO_3$)

1.	Concentration:	38%
2.	pH:	3.8
3.	Specific Gravity:	1.33
4.	Capacity:	60 gpm @ 20-ft TDH
5.	Number of Pumps Installed:	1
6.	Maximum Motor Size:	2 hp

B. Antiscalant (A.S.)

1.	Concentration:	100%
2.	pH:	3
3.	Specific Gravity:	1.10
4.	Capacity:	60 gpm @ 20-ft TDH
5.	Number of Pumps Installed:	1
6.	Maximum Motor Size:	2 hp

C. Sodium Hypochlorite (NaOCl)

1.	Concentration:	12.5% (Diluted to 6.25% onsite)
2.	pH:	13
3.	Specific Gravity:	1.12
4.	Capacity:	60 gpm @ 20-ft TDH
5.	Number of Pumps Installed:	1
6.	Maximum Motor Size:	2 hp

D. Sodium Hydroxide (NaOH)

1.	Concentration:	50%
2.	pH:	14 s.u.
3.	Specific Gravity:	1.53
4.	Capacity:	60 gpm @ 20-ft TDH
5.	Number of Pumps Installed:	1
6.	Maximum Motor Size:	2 hp

E. Fluoride (FLUOR.)

1.	Concentration:	23%
2.	pH:	1.20
3.	Specific Gravity:	1.20
4.	Capacity:	60 gpm @ 20-ft TDH
5.	Number of Pumps Installed:	1
6.	Maximum Motor Size:	2 hp

F. Corrosion Inhibitor (PHOS.)

1.	Concentration:	28.5%
2.	pH:	3.8
3.	Specific Gravity:	1.29
4.	Capacity:	60 gpm @ 20-ft TDH
5.	Number of Pumps Installed:	1
6.	Maximum Motor Size:	2 hp

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SECTION 43 3225

FORCED DRAFT DEGASIFIER TOWERS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This Section includes the design, fabrication, materials, installation, and testing of FRP degasifiers for removing carbon dioxide from NF permeate.

1.2 REFERENCES:

A. American Society of Civil Engineers (ASCE):
   1. 7: Minimum Design Loads for Buildings and Other Structures

B. American Society of Mechanical Engineers (ASME):
   1. B16.1: Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
   2. B16.5: Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

C. ASTM International (ASTM):
   1. A193/A193M: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
   2. A194/A194M: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
   3. C581: Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service
   4. D638: Standard Test Method for Tensile Properties of Plastics
   5. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
   6. D2563: Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
   7. D2584: Standard Test Method for Ignition Loss of Cured Reinforced Resins
   8. D3299: Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
   9. D4024: Standard Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
   10. D5421: Standard Specification for Contact Molded “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
   11. F467: Standard Specification for Nonferrous Nuts for General Use
   12. F468: Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
   13. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

D. NSF International (NSF):
   1. 61: Drinking Water System Components - Health Effects

1.3 SUBMITTALS:

A. Submit the following shop drawings in accordance with Division 01, Section “Submittal Procedures”.
   1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size and arrangement as indicated and specified.
   2. Shop drawing data for accessory items.
   3. Certified setting plans, with tolerances, for anchor bolts.
   4. Manufacturer’s literature as needed to supplement certified data.
   5. Operating and maintenance instructions and parts list.
   6. Listing of reference installations as specified with contact names and telephone numbers.

B. Submit degasifier layout drawings showing dimensions, wall thickness, mounting brackets, knuckle radii, inlet and outlet nozzle location and orientation, and construction.

C. Submit installation instructions for installing tower on a concrete slab.

D. Submit manufacturer's catalog data and descriptive literature for tower system and associated equipment. Submit dimensional drawings. Show materials of construction by ASTM reference and grade. Show coatings, appurtenances, anchor bolts (number, size, and method of fastening), and hardware.

E. Submit manufacturer's catalog information on the packing proposed to be used. Submit calculations to verify depth of media required.

F. Submit hydraulic calculations to show even distribution of water over the media.

G. Submit tower manufacturer’s recommended bolt torques for flanges.

H. Submit a certificate listing the resin to be used, its composition, and that it is NSF approved for use in potable water. Show glass and resin content and thickness of the component sections.

I. Submit calculations for structural and seismic design of walls and design of tie-down lugs (number, size, and embedment length of anchor bolts) signed and sealed by an engineer registered in the State of Ohio. Also submit erection calculations prepared and signed by an engineer registered in the State of Ohio for lifting hardware, erection stresses, strong-backs, and other hardware required during erection of the unit. Provide erection drawings.

J. Submit sample copies of the data forms and report forms for recording and reporting laboratory test data.

K. Submit copies of a laboratory report showing the results of tests conducted on cutouts from the tower shells. Perform the following tests on each tower:
   1. Glass content, degree of cure, and physical properties as described in ASTM D3299, Sections 10 and 11.
   2. Glass content of total tower wall thickness per ASTM D2584.
   3. Submit test reports before shipping towers to the project site. Do not ship towers until after the Owner has reviewed the test reports.
   4. Recommended spare parts other than those specified.
   5. Recommendations for short and long term storage.
   6. Recommended baffle design, if baffles are required.

7. Hoist data and dimensional data.
8. Qualifications of Field Service Engineer.
9. Tag numbers for all equipment.
10. Special tools.
11. Number of service person-days provided and per diem field service rate.
12. Field inspection/testing reports.
13. Material Certification
    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
14. Operation and Maintenance Manual. O&M Manuals shall be in accordance with Division 01, Section "Operation and Maintenance Data".

1.4 SPARE PARTS:

A. Comply with the requirements specified in Division 01, Section "Product Requirements".

B. Provide spare parts that are identical to and interchangeable with similar parts installed
   1. One set of all special tools required.

1.5 QUALITY ASSURANCE:

A. Comply with the requirements specified in Division 01, Section "Quality Control".

B. Forced draft degasifier towers are to be the product of one manufacturer.

C. Mixers to be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Service of Manufacturer's Representative as stated in Division 01, Section "Quality Control" and as specified herein.

E. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified.
   1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve the Contractor of the obligation to provide sufficient services to place equipment in operation as specified.
   2. Installation: Inspect location of anchor bolts, setting, leveling, alignment, field erection, etc.; coordination of piping, electrical and miscellaneous utility connections; but not less than:
      a. 2 person-days
   3. Functional Testing: Calibrate, check, align and perform functional testing with water: Tests to include all items specified.

a. 1 person-days
b. Provide letters from Contractor certifying that the field and functional testing has been completed and that the equipment is operational and ready for field performance testing.

4. Field Performance Testing: Field performance test equipment as specified.
   a. 1 person-days per system
5. Vendor Training: Provide classroom and field operation and maintenance instructions, including all slides, videos, handouts and preparation to lead and teach classroom sessions:
   a. 0.5 person-days.
6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

F. Manufacturer of forced draft degasifier tower must have a minimum of five (5) years of successful operating experience with the size and type of mixer and service conditions specified and indicated.

1.6 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Division 01, Section “Product Requirements”.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS:

A. Design the degasifiers to remove carbon dioxide from the NF Permeate.

2.2 MANUFACTURERS:

A. DeLoach Industries, Inc.

B. Tonka Equipment Co.

2.3 DEGASIFIER TOWER CONSTRUCTION:

A. The degasifiers shall be forced draft FRP countercurrent slat tray towers. Provide the degasifiers complete including the structural housing, media, media support, access panels, connections for piping and ducting, header lateral water distribution system, air inlet, air inlet transition duct, demister, air outlet, liquid outlet, and structural anchorage.

B. See drawings for degasifier layout and nozzle orientation.

C. The degasifier tower shall be square in cross section with a cover and venturi-shaped stack projecting at least 18 inches above the cover section.

D. Vessel or tower internal components, except the media, shall be factory installed.

E. The vessel or tower base shall be flat and shall contain the necessary lugs for anchoring to the concrete base. The base shall include a liquid outlet at the vessel center, as shown in the drawings. Fit the liquid outlet with a vortex breaker in the form of a nozzle.

F. The minimum wall thickness shall be 1/4 inch. Maximum wall deflection under any combination of loading conditions shall be 1/4 inch. Sandwich laminate construction shall be permitted.

G. Fit the degasifier tower with the following flanged nozzles. Refer to the drawings for size and orientation of nozzles.
1. One (1) influent nozzle.
2. One (1) effluent nozzle.
3. One (1) drain nozzle.
4. One (1) air inlet nozzle.
5. Two (2) media access hatches.

H. The inlet distribution system shall be a piping grid with nonclog spray nozzles to assure a uniform liquid distribution over the packing media. Design shall provide for field adjustment.

2.4 RESIN:

A. Resin: Derakane 411-350 WSR. Resin shall be suitable for continuous immersion in the liquid described in the subsection herein on "Service Conditions" and shall be resistant to those fluids as defined by ASTM C581.

2.5 STRUCTURAL DESIGN AND SUPPORTS:

A. Design anchors and anchor bolts per the following requirements:

B. Seismic Design Parameters
1. Refer to the structural drawings.

C. Wind Design Parameters
1. Refer to the structural drawings.

D. An unreinforced concrete structural slab shall not be considered to have structural value in the design of the anchor bolts. Tension and shear values for drilled or epoxied anchor shall be ICBO approved. Maximum hoop stress shall not exceed 1/10 of the ultimate hoop strength of the laminate.

E. The loading conditions for the design of the degasifier and attachment to the concrete slab shall also include a roof load of 10 psf (0.5 kPa), material dead loads, forces imposed by the liquid splashing downward, and forces imposed by the air moving upward.

2.6 LAMINATE CONSTRUCTION:

A. Provide at least three inner laminated layers as a corrosion barrier on the tower interior totaling a minimum of 100 mils (2.5 mm) in thickness. The inner layer shall be resin rich, shall consist of a NSF certified for potable water polyester organic fiber, and shall be a minimum of 20 mils (0.5 mm) thick. Glass content in the inner layer shall be 20 percent +/- 5 percent by weight.

B. The remaining two layers shall be composed of 1-1/2 lb/min chopped strand mat having a glass content of 25 percent +/- 5 percent applied at a rate of 3 ounces per square foot (955 mL/m^2) (915 g/m^2). The inner liner shall be formed not sprayed. Chopped roving fibers shall be 1/2 to 2 inches (13 to 50 mm) in length.

C. The average glass content of the inner three layers shall be 27 percent +/- 5 percent by weight.

D. The exterior layer shall be contact molded finish with a UV protected Gelcoat finish.

E. The total tower wall thickness shall have an average glass content of 55 percent by weight +/- 5 percent per ASTM D2584.

2.7 FRP:

A. Maximum tensile and flexural stress under any loading conditions shall not exceed 1,500 psi (10 MPa).

B. Laminate mechanical and physical properties for FRP elements shall be as follows:
1. Ultimate Tensile Strength per ASTM D638: 11,000 psi (76 MPa) minimum.
2. Flexural Strength per ASTM D790: 16,000 psi (110 MPa) minimum.
3. Flexural Modulus of Elasticity per ASTM D790: 900,000 psi (6205 MPa) minimum.

2.8 QUALITY CONTROL:

A. Construction shall comply with ASTM D2563, Level II, except that maximum frequency of air bubble in liner portion of laminate shall be 10 per square inch (15,500/m^2) of laminate with maximum bubble size of 1/16-inch (1.6 mm). Wall hardness shall be at least 90 percent of the resin manufacturer's recommended Barcol hardness, with a minimum Barcol hardness of 30, with the resin fully cured. Maximum strain in the laminate shall be 0.001 inch/inch (mm/mm). Maximum air bubble size in the laminate shall be 1/16 inch (1.6 mm). Maximum strain in the laminate shall be 0.001 inch/inch. Appearance of the tower interior and exterior shall comply with ASTM D3299, Section 9.

2.9 ULTRAVIOLET PROTECTION:

A. Provide ultraviolet protection in the form of a surface coating of a permanent Gelcoat rich exterior layer, pigmented white. Surfaces shall be smooth, hard, and glossy. Thickness of this external layer shall be at least 10 mils (0.25 mm).

2.10 REINFORCEMENT AT OPENINGS:

A. Where nozzles, manways, or openings are provided, reinforce the tower wall with a min of eight layers composed of 1-1/2 lb min chopped strand mat having a glass content of 25% +/-5 percent applied at a rate of 3 ounces per square foot (955 mL/m^2)(915 g/m^2). Chopped roving fibers may be utilized and then covered with chopped strand. All reinforcing shall be a minimum ½ to ¾ inches thick.

B. For openings 12 inches (300 mm) and larger, provide additional reinforcing plies of woven roving and chopped glass in the structural layers of the tower base wall laminate at the opening location point when the tower shell is built.

2.11 TIE-DOWN LUGS AND ANCHOR BOLT MATERIALS:

A. Tie-down lugs shall be FRP material bonded to the FRP tower shell to meet all required structural and seismic load requirements specified. Anchor bolts shall be Type 316 stainless steel. Bolts shall conform to ASTM A193, Grade B8M. Nuts shall conform to ASTM A194, Grade 8M. Lugs shall be FRP integrally bonded by hand layout to assure control thickness and structural integrity. Design bolts and washers to prevent bolt pull out due to uniform and nonuniform vertical, horizontal, torsional, fatigue, and cyclical loading.

2.12 FLANGED NOZZLES:

A. Nozzles shall be flanged, minimum 2-inch (50 mm) size. Flange bolting pattern dimensions shall conform to ASME B16.5, Class 150.

B. Flanged nozzles shall have conical gusset supports and shall be designed for a minimum torque of 2,000 foot-pounds (2700 Nm) and a minimum bending moment of 1,500 foot-pounds (2000 Nm). Attach the gusset to the full perimeter of the flange and at the intersection with the tower wall to provide 360-degree distribution of stresses. Nozzle construction shall be of the molded type per ASTM D3299.

C. Flanges shall be FRP, conforming to ASTM D4024 or D5421. The resin used to manufacture the flanges shall be NSF certified for potable water and the same as that used to manufacture the tower. Flanges shall be flat faced. Flange thickness shall be at least 1.5 times the nozzle wall thickness, with a minimum flange thickness of 1/2-inch (13 mm).

2.13 GASKETS FOR FLANGED NOZZLES AND MANWAYS:

A. Gaskets for flanged nozzles and manways 12 inches (300 mm) and smaller shall be full faced, 3/16-inch (5 mm) thick, having a hardness of 50 to 70 durometer A. Gaskets for nozzles and manways larger than 12 inches (300 mm) shall be full faced, 1/4-inch (6 mm) thick, having a hardness of 50 to 70 durometer A. Gasket material shall be EPDM. When the mating flange has a raised face, remove the raised face.

2.14 BOLTS AND NUTS FOR FLANGED NOZZLES AND MANWAYS:

A. Bolts shall be Type 316 stainless steel, per ASTM A193, Grade B8M. Nuts shall conform to ASTM A194, Grade 8M. Provide washer for each nut and bolt head. Washers shall be of the same material as the nuts.

2.15 FLAT BOTTOM HEADS:

A. Construct flat bottom heads integrally with the tower shell as one seamless piece.

2.16 RADIUS OF TURNS AND KNUCKLES:

A. Tanks or towers shall have minimum knuckle radii of 1 1/2 inches.

2.17 LIFTING LUGS:

A. Provide at least four side-mounted lifting lugs on each tower.

2.18 PIPE SUPPORTS:

A. Pipe supports shall be FRP integrally laminated into the tank or tower shell. Bolts, nuts, washers, and screws shall be Type 316 stainless steel. Provide washer under each nut, bolthead, and screw head.

2.19 TOWER MEDIA AND MIST ELIMINATOR:

A. Media shall be PVC slat trays. The slat trays shall be removable through the tower access manway. A single slat tray shall consist of convex PVC slats attached to a 4-inch-deep FRP channel frame nominal 4 feet by 12 feet (1200 mm x 3650 mm) using slot head stainless steel screws with nylon grips. The PVC slats shall be staggered from tray to tray to facilitate mass transfer. The slat trays shall be self-spacing, self-supporting, and self-aligning with the bottom tray.

B. Mist eliminator shall be polypropylene Koch-Glitsch, LP Flexichevron Style I, Munters Corporation DV 270 (T 271). Mist eliminator shall remove a minimum of 99 percent of entrained droplets down to 40 microns in diameter. Polypropylene used for the mist eliminator shall have the following properties:

Density	0.90 g/mL
Tensile strength	4,900 psi (34 MPa) minimum
Flexural yield stress	6,000 psi (41 MPa) minimum
Flexural modulus of elasticity	170,000 psi (1172 MPa) minimum

2.20 LIQUID DISTRIBUTOR AND MIST ELIMINATOR STRUCTURAL SUPPORT MEMBERS:

A. Provide FRP structural members to support liquid distributor and mist eliminators. Structural members shall not obstruct more than 10 percent of the tower cross-sectional area.

2.21 LIQUID DISTRIBUTORS:

A. Liquid distributor shall be a header lateral using the non-clog spray nozzle type as manufactured by DeLoach Industries Inc. Distributor shall be accessible through the tower access manways.

2.22 EXHAUST STACK:

A. The exhaust stack shall be constructed of FRP in the same manner and thickness as the degasifier shell. The stack shall be square with a 316 SST insect screen and rainshield.

B. Provide stainless steel bird screen over the exhaust stack opening. The bird screen shall be 1/2-inch-square mesh fabricated of 0.063-inch, Type 316 stainless steel wire.

2.23 BLOWER:

A. Blowers shall be supplied by the Degasification manufacture and shall be factory fitted to the connection transition duct and the degasification tower. Blower make shall be Loren Cook.

B. Overall sound-pressure level of each blower/motor assembly shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet from motor.

2.24 MOTORS:

A. Provide in accordance with Division 26, Section "Motors" and as specified and indicated.

B. Horsepower rating of motors: Not less than maximum brake horsepower requirements of blower under any condition of operation specified and indicated without operating in the motor service factor.

C. Motor enclosure and motor speed: As indicated in the Blower Schedule.

D. In addition to the requirements for bearings specified under Electric Motors in Division 26, Section "Motors", provide blower motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

E. Operate without overheating at the speeds specified and indicated.

F. Service Factor: 1.15.

G. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

H. Rating: 460V, 3-phase, 60 Hertz.

2.25 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Division 09, Section "High Performance Coatings".

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.26 AIR INLET TRANSITION DUCT:

A. Design and provide a transition air duct from each fan to the inlet flange of each degasifier. Duct shall have flanged inlet and outlet connections. Construct the duct in the same manner and thickness as the degasifier shell.

PART 3 - EXECUTION

3.1 INSPECTION:

A. After delivery to the site, the Owner will check FRP elements for cracks, holes, and other characteristics listed in ASTM D2563, Table I. Remove any FRP item not complying with ASTM D2563, Table I, Level II from the project site.

3.2 TOWER INSTALLATION:

A. Install towers level as shown in the drawings. Erect vertical towers in accordance with ASTM D3299, Appendix X1.2. Provide a rubber pad or layers of roofing felt between the tower bottom and the underlying slab as recommended by the tower manufacturer.

B. Set each degasifier in place on the elevated slab, leveled and anchored to the slab.

C. Load tower media.

3.3 INSTALLATION VERIFICATION:

A. Prior to checking final piping alignment to the tower, the piping system shall be complete as follows.

B. Complete pipe pressure testing, dry out the system, and remove hydrotest blind flanges.

C. Install and adjust permanent supports and hangers.

D. Remove temporary supports and hangers.

E. The system piping components and tower shall be at the same ambient temperature within a range of 10 degrees F (6 degrees C) before starting final piping alignment checks.

F. Verify that the connecting tower piping is properly constructed. This inspection shall include verification of gasket material, gasket size, and the material, size, and length of flange bolts, studs, and nuts.

3.4 INSTALLING BOLTS AND NUTS FOR FIBERGLASS FLANGES AND MANWAYS:

A. Prior to fit-up, lubricate the threads of the bolts and nuts per Division 40, Section “Process Piping”. Tighten the nuts by hand until they are snug. Use a torque wrench to tighten the nuts. Tighten the nuts in 5 lbf-ft (7 Nm) increments according to the sequences shown in Figure 2 of ASTM D4024 or Figure 3 of ASTM D5421. For flanges with more than 20 bolts, use similar alternating bolt tightening sequences. Increase the bolt torque uniformly to the level recommended by the flange manufacturer for field installation.

3.5 FLANGE AND PIPING ALIGNMENT REQUIREMENTS:

A. Do not spring flanges of connecting piping into position.

B. Line up pipe flange bolt holes with tower nozzle bolt holes within 1/16-inch (1.6 mm) maximum offset from the center of the bolt hole to permit insertion of bolts without applying any external force to the piping.

C. The tower and piping flange faces shall be parallel to less than 0.001 inch per inch (mm/mm) of pipe flange outer diameter up to a maximum of 0.030 inch (0.76 mm). For piping flange outer diameters smaller than 10 inches (250 mm), the flanges shall be parallel to 0.010 inch (0.25 mm) or less.

D. Flange face separation shall be within the gasket spacing +/-1/16 inch. Use only one gasket per flanged connection.

E. Separately work connecting piping systems into position to bring the piping flanges into alignment with the matching tower flanges. Do not move tower to achieve piping alignment.

3.6 LABELING AND MARKING:

A. Provide a tag for the unit bearing the tag number, unit capacity, and pertinent design information.

3.7 FIELD TESTING:

A. Operate the degasifier system under design conditions for 24 hours. Correct any deviations from normal operation such as excessive vibration, noise, or other abnormal operation at no additional cost to the Owner. Verify that the pressure, flow rate, and motor amperage are within 5 percent of the values shown on the certified rating.

B. Adjust inlet distribution and media depth as necessary during initial plant start-up and testing.

3.8 CONTRACT CLOSEOUT

A. Provide in accordance with Division 01, Section “Closeout Procedures”.

END OF SECTION 43 3225

RARWTP DEGASIFIER SCHEUDLE

A. Degasifiers

1.	Tag Nos:	DG-1, DG-2
2.	Number of Units:	Two (2)
3.	Location:	Outdoors
4.	Capacity:	3,090 gpm
5.	Maximum Loading Rate:	26 gpm/SF
6.	Dimensions (max):	11-ft x 11-ft x 12-ft (L x W x H)
7.	Packing Bed Depth:	7-ft
8.	Inlet Size:	12-inch
9.	Outlet Size:	16-inch (DG-2 has offset outlet, see drawings)
10.	Blower:	
	a. Electrical:	460 volts, 3 phase, 60 Hz
	b. Maximum Motor Size:	7.5 hp
	c. Enclosure:	TEFC
	d. Service Factor:	1.15
11.	Influent Water Quality	
	a. pH:	5.73 s.u.
	b. Temperature:	55 degrees C
	c. Alkalinity:	8.6 mg/L as $CaCO_3$
12.	Performance Requirement:	>90% removal Free CO_2

SECTION 46 0630

PROCESS CHEMICALS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section.

B. Description of Work
   1. Provision of process chemicals

1.2 QUALITY ASSURANCE

A. Chemical suppliers shall have been regularly engaged in the manufacture of the specified chemicals for a minimum of five years.

1.3 SUBMITTALS

A. For all chemicals submit the following:
   1. MSDS.
   2. Product name and manufacturer.
   3. Product data.

B. Submit procedures and chemicals used for cleaning and sterilization for start-up and commissioning of membrane systems and chemical feed systems.

1.4 HANDLING, DELIVERY, AND STORAGE

A. Handling, delivery, and storage of each chemical shall be in accordance with the manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 CHEMICALS PROVIDED VIA BULK DELIVERY

A. Sodium Bisulfite ($NaHSO_3$)
   1. Type: – liquid solution.
   2. NSF 60 certification required.
   3. Grade: Technical.
   4. Concentration: 38%
   5. Specific Gravity: 1.33
   6. Sodium Sulfate: <3.5%.
   7. pH: 3.6 - 4.6.
   8. Density: 10.93 - 11.43.
   9. Iron: <15 ppm.
   10. Manufacturer: Nalco, Bonded, Kemira, Brenntag, Univar or equal.

B. Sodium Hydroxide (NaOH)

1. Sodium hydroxide shall conform to ANSI/AWWA B501
2. Type: Sodium Hydroxide, Liquid Solution.
3. Grade: Technical.
4. NSF 60 certification required.
5. Concentration: 50%.
6. Specific Gravity: 1.53
7. Freezing Point: -20 deg F.
8. Manufacturer: Nalco, Bonded, Kemira, Brenntag, Univar or equal.

C. Corrosion Inhibitor (PHOS.)
1. Aqueous solution of orthophosphate commercial formulation designed to control red water, remove rust and scale deposits from water lines, and protect against corrosion or pitting.
2. Form: Clear homogeneous liquid
3. Concentration: 28.5% total phosphate
4. Freezing point: <24 deg F.
5. Shelf life (neat): 1 year.
6. Freeze/thaw stable.
7. Totally soluble at any dilution.
8. NSF 60 certification required.
9. Specific Gravity: 1.29 – 1.35
10. pH: 3.8, +/- 0.5
11. Manufacturer: Carus 4500 or equal

D. Sodium Hypochlorite (NaOCl):
1. Sodium Hypochlorite Solution conforming with ANSI/AWWA Standard B300
2. Type: Sodium Hypochlorite solution in bulk.
3. Concentration: Nominal 12.5%, as Cl_2. (Diluted to 6.25% onsite)
4. Vapor pressure: 12.1 mm Hg @20ºC
5. Density: 10.0 lbs/gal
6. pH: 11.2 – 11.4
7. NSF 60 certification required.
8. Manufacturer: Nalco, Bonded, Kemira, Brenntag, Univar or equal.

E. Fluoride (FLUOR.)
1. Fluorosilicic Acid shall conform to the requirements of ANSI/AWWA B703-00
2. NSF 60 certification required.
3. Concentration: 23%, +/- 1%.
4. Boiling Point: 222 deg F (105 deg C)
5. Freezing Point: -4 deg F (-15.5 deg C)
6. Specific Gravity: 1.20
7. Solubility in Water: Complete.
8. Molecular Weight: 144.08
9. pH (1% solution): 1.2
10. Appearance and Odor: Water white to straw yellow burning liquid with pungent odor.
11. Manufacturer: Nalco, Bonded, Kemira, Brenntag, Univar or equal.

2.2 CHEMICALS PROVIDED IN TOTES

A. Antiscalant (A.S.):

1. Antiscalant shall inhibit the formation and growth of alkaline earth carbonate and sulfate scales, disperse suspended solids and colloids, and stabilize metallic ions.
2. Antiscalant shall eliminate acid feed for scale control by inhibiting the precipitation of calcium carbonate up to a calcium carbonate nucleation index (CCNI) of 2.3. Antiscalant shall maintain scale inhibition even in the presence of iron. Antiscalant shall inhibit calcium carbonate scale up to an LSI of 2.6 and a CCPP of 900.
3. NSF 60 certification required.
4. Form: Liquid.
5. Appearance: Clear colorless to yellow liquid
6. Solubility in Water: complete.
7. Specific Gravity: 1.10 +/- 0.05
8. pH: 3 - 4.
9. Manufacturer: AWC A-102 Ultra

PART 3 - EXECUTION (NOT USED)

END OF SECTION 46 0630

RARWTP PROCESS CHEMICAL SCHEDULE

A.

CHEMICAL	CONTRACTOR TO PROVIDE:
Sodium Bisulfite ($NaHSO_3$)	45,000 lbs
Sodium Hydroxide (NaOH)	45,000 lbs
Corrosion Inhibitor (PHOS.)	45,000 lbs
Antiscalant (A.S.)	Three (3) 275 gallon totes
Sodium Hypochlorite (NaOCl)	45,000 lbs
Fluoride (FLUOR.)	45,000 lbs

SECTION 46 3323

LIQUID CHEMICAL WEIGHING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The Work of this Section includes providing and installing load-cell type chemical container scales and indicators for chemical day tanks.

1.2 QUALITY ASSURANCE

A. Provide and install equipment adequate in size, capacity, and number to accomplish the work of this Section in a safe and timely manner.

B. Scales shall have a full-scale accuracy better than 1/4 of 1%. Equipment not meeting this requirement shall be replaced at no additional cost to the owner.

1.3 DELIVERY, STORAGE, & HANDLING

A. Delivery, storage, and handling shall meet the requirements of manufacturer/supplier in general and the following specifically:
   1. Shipping: Pack all spare parts in containers bearing labels clearly designating contents and the specific equipment for which they are intended.

B. Receiving
   1. Contractor shall inspect and inventory items upon delivery to site.
   2. Contractor shall store and safeguard equipment, material, instructions, and spare parts in accordance with manufacturer's written instructions.

1.4 SUBMITTALS

A. Manufacturers literature, illustration, specifications and engineering data including: dimensions, materials, size, weight, performance data, flow rate, motor horsepower (or current draw) and speed.

B. Operation and Maintenance Manual. O&M Manuals shall be in accordance with Division 01, Section “Operation and Maintenance Data”.

C. Contractor shall verify chemical compatibility of piping, solvents, gaskets, seals, o-rings, etc. for each chemical feed system. Provide chemical compatibility charts and manufacturer’s written verification of compatibility for each chemical feed system.

1.5 WARRANTY

A. Scales shall carry a full five (5) year factory warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Force Flow Equipment

B. Eagle Microsystems Inc.

C. Scaletron Industries LTD

2.2 CHEMICAL DAY TANK SCALES

A. Scales for day tanks shall be suitable for weighing the chemical noted on the Drawings and shall be of the digital readout/electronic load cell type.

B. Platform height shall be of the low profile type and have four adjustable hold down lugs.

C. Scales shall have 80 mil minimum dry thickness epoxy coating that is resistant to moisture, chemicals, abrasion, impact and UV light.

D. Scales shall be of the single load cell design with the weight transferred by a pivoted platform to a single load cell of the shear beam strain gauge type.

E. A flexible cable shall connect the load cell to the indicator readout. Cable length shall be field measured.

F. Scales shall be Force Flow Industries Chem-Scale with Tuff-coat Environmental Armor or approved equal. The max capacity (lbs) and the size of the day tank shall be as provided herein.

2.3 INDICATOR DISPLAY

A. Instrument Enclosure, Outputs & Alarms: Indicator shall carry CE marking and shall be housed in a NEMA 4X, UL approved enclosure. Power supply is 120 V, 1-phase, 60 hertz.

B. The indicator shall have the following features:
   1. Number of Channels: As indicated in the scale schedule.
   2. 20-key digital keypad & ability to display the required number of channels simultaneously.
   3. An adjustable 4-20 mA signals that output the net weight and chemical feed rate for each scale.
   4. Display an alarm in any of the following conditions: Low level, high level, low feed rate, high feed rate, max daily use, min. daily use, supply exhausted, and load cell failure. An alarm log shall store the most recent 10 alarm conditions with time and date of occurrence.
   5. Provide one 4-20 mA outputs and 6 alarm/control output contacts per channel for each of the chemicals listed in the schedule.

C. Display & Inventory Control Software: Keypad and menu items shall have independent password protection to prevent unauthorized operation. A numerical and bar graph display shall give operator the ability to monitor chemical by weight, volume, or percent full. Each channel shall have a user selectable, two digit scale ID number and shall display net remaining, pure

chemical remaining, feed rate, daily usage, total amount used, days until empty, gross weight, and tare weight. A TANK LOAD key shall pause & project usage accumulation during chemical re-supply to maintain accurate usage data over multiple tank loads. A data log shall store the daily usage for each of the previous 31 days. Indicator re-calibration in the field shall be accomplished through the keypad and shall not require the use of dead weights.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall install items as specified and as shown on the Drawings in accordance with manufacturer's printed instructions.

B. All electrical power and control connections shall be furnished under division 26.

3.2 MANUFACTURER'S SERVICES

A. Conform to the requirements of Division 01, Section “Quality Control”.

B. Provide a minimum of two trips for a total of 32 hours on site for startup and coordination with General Contractor and the process equipment OEM.

C. Startup services and training of Owner's personnel shall be at such times as requested by the Owner.

D. Additional time required to perform these services shall be at no additional cost to the Owner. The Owner shall be credited for the unused portion of startup services.

END OF SECTION 46 3323

RARWTP SCALE SCHEDULE

A. Sodium Bisulfite (NaHSO3)
   1. Chemical Properties:
      a. SG: 1.33
      b. Concentration: 38%
   2. Day Tank Dimensions:
      a. See Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances".
      b. Tank dimensions will vary with tank manufacturer. Scale manufacturer to verify tank dimensions with Contractor.
   3. Indicator:
      a. Number of Channels: 1
   4. Capacity: 0 – 1500 lbs

B. Antiscalant (A.S.)
   1. Chemical Properties:
      a. SG: 1.10 ± 0.05
      b. Concentration: 100%
   2. Day Tank Dimensions:
      a. See Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances".
      b.
      c. Tank dimensions will vary with tank manufacturer. Scale manufacturer to verify tank dimensions with Contractor.
   3. Indicator:
      a. Number of Channels: 1
   4. Capacity: 0 – 500 lbs

C. Sodium Hydroxide (NaOH)
   1. Chemical Properties:
      a. SG: 1.53
      b. Concentration: 50%
   2. Day Tank Dimensions:
      a. See Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances".
      b. Tank dimensions will vary with tank manufacturer. Scale manufacturer to verify tank dimensions with Contractor.
   3. Indicator:
      a. Number of Channels: 1
   4. Capacity: 0 – 4000 lbs

D. Fluoride (FLUOR.)
   1. Chemical Properties:
      a. SG: 1.20
      b. Concentration: 23%
   2. Day Tank Dimensions:
      a. See Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances".

b. Tank dimensions will vary with tank manufacturer. Scale manufacturer to verify tank dimensions with Contractor.

3. Indicator:
   a. Number of Channels: 1
4. Capacity: 0 – 1000 lbs

E. Corrosion Inhibitor (PHOS.)
1. Chemical Properties:
   a. SG: 1.29
   b. Concentration: 28.5%
2. Day Tank Dimensions:
   a. See Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances".
   b. Tank dimensions will vary with tank manufacturer. Scale manufacturer to verify tank dimensions with Contractor.
3. Indicator:
   a. Number of Channels: 1
4. Capacity: 0 – 2000 lbs

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SECTION 46 3344

CHEMICAL PERISTALTIC METERING PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Provide and test chemical peristaltic metering pumps and appurtenances, as indicated and in compliance with Contract Documents.

B. Provide each chemical pumping system complete. And before acceptance make each system fully operational and ready for use by the Owner.

C. Chemical systems to meet:
   1. Recommended Standards for Water Works (2012 edition or the latest revision), Part 5.

D. Connections of electrical, control and instrumentation components shall be furnished and installed as specified in divisions 26 and 40 9XXX.

1.2 REFERENCES:

A. ASTM International (ASTM):
   1. A36: Standard Specification for Carbon Structural Steel
   2. A48: Standard Specification for Gray Iron Castings
   3. A322: Standard Specification for Steel Bars, Alloy, Standard Grades
   4. A570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality

B. National Electrical Manufacturers Association (NEMA):
   1. ICS 1: Industrial Control and Systems General Requirements
   2. MG1: Motors and Generators

C. Recommended Standards for Water Works (2012 edition or the latest revision), Part 5.

1.3 SUBMITTALS:

A. Submit the following shop drawings in accordance with Division 01, Section “Submittal Procedures”:
   1. When the Contractor proposes equipment which requires an arrangement differing from that indicated on the drawings or specified, prepare and submit for review detailed structural, mechanical, and electrical drawings and equipment lists, utilities consumption schedule and operating instructions, showing necessary changes and embodying special features of the equipment he proposes to furnish. Make changes, if accepted at no additional cost to Owner.
   2. Submit certified shop drawings, manufacturer's specifications, catalog data, descriptive literature, illustrations, and other materials necessary for proper appraisal of quality and function.
   3. Include factory work sheets which identify each piece of equipment as specified herein and on drawings.

4. Sales bulletins or other general publications are not acceptable as submittals for review except where necessary to provide supplemental technical data.
5. Number and identify equipment to correspond with terminology on drawings. Use these numbers on all submittal sheets and shop drawings.
6. Furnish for each system piping schematic and wiring schematic with interconnection diagram and a complete description of operation.
7. Pump Control Panel:
    a. Front elevations, with and without door.
    b. Elementary wiring connection diagram.
    c. Catalog sheets for devices in the control panel.
    d. Use NEMA device designations and symbols for electric diagrams. Make contents of elementary connection diagrams in accordance with NEMA ICS 1.
    e. Manufacturer's standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.
8. Vendor to confirm with calculations that the pumps offered can handle the piping as shown.
9. Operating and maintenance instructions and parts lists.
10. Templates or certified setting plans, with tolerances, for anchor bolts.
11. Recommended spare parts other than those specified.
12. Recommendations for short and long term storage.
13. Submit recommended charging pressures for pulsation dampeners.
14. Submit accuracy and readability limits for pump speed indicators.
15. Manufacturer's product data and specifications for shop painting.
16. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
17. The latest ISO 9000 series certification or certified quality assurance/control program document.
18. Provide qualifications of service/start-up personnel.
19. Material Certification:
    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Based on incompatibility with the service conditions, provide technical data and provide proposed materials.
    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
20. O&M Manuals. O&M Manuals shall be in accordance with Division 01, Section "Operation and Maintenance Data".

1.4 QUALITY ASSURANCE:

A. Comply with the requirements specified in Division 01, Section "Quality Control".

B. General:

1. Do the work required by and in accordance with applicable State and local codes; arrange for all permits, inspections and tests required by these codes. Provide systems and items of equipment that conform to applicable safety standards including those for safety of personnel.
2. One vendor to provide equipment and appurtenances, regardless of manufacturer, and is responsible for the satisfactory operation of the systems. Substitutions on functions specified are not acceptable.
3. Provide components to manufacturer's standard for service intended unless otherwise required.
4. Pumps of the same type to be the product of one manufacturer. Provide equipment of manufacturers' latest and proven design. Pumps to be standard cataloged products.
5. Drawings and specifications direct attention to certain required features of the equipment, but do not purport to cover all details entering into its design, construction and installation; nevertheless, furnish and install equipment so that systems will be complete and ready for operation.

C. Service:
1. Services of Manufacturer's Representative stated in Division 01, Section “Quality Control" and as specified herein.
2. Provide services of factory-trained Service Personnel, specifically trained on type of equipment specified.
   a. Submit qualifications of Service Engineer for review.
   b. Person-day requirements listed exclusive of travel time, and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.
   c. Installation: Sufficient time to assist in location of anchor bolts; setting, leveling, alignment, field erection, etc.; coordination of piping, electrical, miscellaneous utility connections, but not less than:
      1) 3 person-days per treatment facility.
   d. Start-Up: Sufficient time for calibration, testing and start-up, but not less than:
      1) 1 person-days per treatment facility.
   e. Performance Testing: Time for field acceptance testing, but not less than:
      1) 2 person-days per treatment facility.
   f. Instruction: Sufficient time for classroom and/or field operation and maintenance instruction, but not less than:
      1) 1 person-days.
   g. Credit to the Owner unused service person-days specified above at the manufacturer's published field service rate plus any costs of travel.
3. The minimum days specified above does not relieve the manufacturer of responsibility of providing sufficient service to place components and systems in satisfactory operation. Provide, in addition to time periods specified above, time and material used to correct defective equipment at no additional cost to Owner.
4. 8-hour days specified are exclusive of travel time.
5. Turn on no form of energy to any part of systems prior to receipt by Engineer of certified statement of approval of installation from Contractor containing his supplier's authorization to energize system unless done by the supplier's servicemen may do so for purposes of checkout.
6. The Manufacturer's Representative must maintain a factory trained serviceman with parts within 150 miles of this Owner.

D. Pumps, Motors and Controllers:
   1. Pump manufacturer shall furnish the pumps, motors, and appurtenances regardless of manufacturer, as a complete package to ensure proper coordination and compatibility of equipment.
   2. Prior to shipment to job site, pump manufacturer must perform a test on the combined motor and pump assembly.

1.5 SPARE PARTS:

A. Furnish following spare parts, identical and interchangeable with similar parts installed in work:
   1. For each chemical metering pump:
      a. One (1) replacement head for each pump provided.
   2. One of each type and material back pressure valve with one spare diaphragm and spring for each.
   3. Provide all other manufacturer's recommended spare parts necessary to maintain each piece of equipment for a period of one year.

B. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which they are intended.

C. Deliver spare parts at same time as equipment to which they pertain. Properly store and safeguard such spare parts until completion of work, and then deliver to Owner.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Division 01, Section “Product Requirements”.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the Metering Pump Schedule.

2.2 GENERAL:

A. Provide systems constructed of components which are compatible and suitable for intended service.

B. Drawings and specifications indicate energy sources that will be provided. Provide all other devices necessary to obtain proper operation of system from these energy sources.

2.3 PERISTALTIC METEIRNG PUMPS:

A. Acceptable manufacturers:
   1. Watson-Marlow Qdos.

B. Configuration
   1. See schedule and drawings.

C. Pump Construction

1. Pumps shall be positive displacement type complete with replaceable cartridge-style peristaltic pumphead and self-contained variable speed drive.
2. Pumps shall be self-priming and shall have a maximum suction lift capability of up to 30' vertical water column.
3. Discharge Pressure Rating: 100 psi continuous (145 psi intermittent for Qdos 30).
4. Pumps shall be capable of pumping both liquids and gases without vapor locking.
5. Pumphead
    a. Technology: Provide tool-free cartridge-style peristaltic pumphead. Pumphead must be serviceable as a single replaceable component.
    b. Housing construction: Corrosion resistant and high impact resistant glass filled PPS or PPE/PS.
    c. Geometry: Pumphead shall consist of sealed track housing with in-line porting. Suction and discharge ports shall be 180 degrees apart with bottom suction and top discharge.
    d. Rotor: Pumphead rotor shall be constructed of glass filled Nylon, sealed within the track housing, and supported by its own bearings. Peristaltic occlusion level shall be factory set to ensure flow accuracy of +/- 1% and repeatability performance of +/- 0.5% and shall not require any field adjustment.
    e. Contact Materials: All pumphead components in the fluid path must be NSF61 listed and shall be of materials specified by the manufacturer as compatible with the process fluid.
    f. Leak containment/detection: In the event of peristaltic element failure, the leak sensor shall shut the pump down immediately with all process fluid contained within the sealed pumphead.
        (1) Sensor type: Utilize non-contacting optical sensor. Sensor shall not come in contact with the process fluid, shall contain no moving parts, shall not depend on the capacitance of the process fluid, shall not require fluid to leak out of the pump housing for engagement, nor shall require any sensitivity or calibration adjustment.
        (2) Alarm: Sensor shall shut down the pump, give a visual indication on the drive controller, and if specified shall provide an output general alarm signal.
        (3) Sealed pumphead shall have a controlled drain-to-waste port.
    g. Port connections: Pumphead shall utilize polypropylene compression fittings which shall mate to 10mm ID reinforced, transparent PVC interface hose. Provide polypropylene compression by ½" NPT adaptors for connecting interface hose to process line.
6. Drive
    a. Rating: Continuous 24 hour operation, 113 degrees F ambient.
    b. Voltage: Drive shall be suitable for 120 VAC, 60Hz, single phase with an internal switch-mode power supply. Supply nine-foot length mains power cord with standard 115VAC three-prong plug.
    c. Max drive power consumption: 190 VA.
    d. Enclosure: NEMA 4X constructed out of corrosion and impact resistant engineering plastic, 20% Glass filled PPE/PS. Enclosure shall house the drive motor and all control circuitry in one integrated unit.
    e. Direct coupled pumphead with fully protected drive
        (1) Pumphead shall direct couple mount to the controller via a splined drive shaft and shall be locked in place by two tool-free thumbscrews or lever mechanism.

(2) Pumphead shall be fully sealed to prevent any contamination of the controller or drive shaft by process fluid.
(3) Pumphead shall contain its own rotor bearings and not impart an overhung load on the pump shaft.
(4) Pumpheads shall be supplied mounted to the left or right side of the drive enclosure as specified in the drawings. If not specified, pumpheads shall mount to right side of the enclosure.
(5) Drive shall stop shaft rotation and give visual alarm in the event the pumphead is removed.

f. Drive motor: brushless DC motor with integral gearbox and closed loop tachometer feedback.
(1) Circuitry complete with temperature and load compensation and protection.

7. Human-Machine Interface (HMI) and Control Manual Control Interface
a. Display: Backlit graphical Display to display pump tag number, flow rate, and programming instructions. Display shall also provide visual indication of running status via screen color: Blue = Running, White = Stopped and Red = Warning.
b. Keypad: Keypad for start, stop, speed increment, speed decrement, rapid prime, and programming.
c. Flow units: Programmable in either ml/min or gallons/hour.
d. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.
e. Auto Restart: feature to resume pump status in the event of power outage interruption.
f. Fluid level monitor: Programmable flow totalization to advise operator when their supply tank is low.
8. Supply auto control features to meet the following minimum functionality requirements.
a. Remote Control Inputs:
1) Start/Stop Control: Digital Input. Configurable command sense allowing open to equal run or open to equal stop. Configurable to be a keypad start/stop override in Manual mode.
2) Speed Command: 4-20mA speed input, with input signal trimmable and speed scaleable over any part of the drive speed range. 1,600:1 turndown with incremental steps of 10 microamps required.
3) Leak Detector Run/Stop Control: Digital Input.
4) Auto/Manual Mode Control: Digital Input.
b. Status Outputs:
1) Pump Fault: Digital Output
2) Speed Status: Analog 4-20 mA Output.
3) Start/Stop Status: Digital Output
4) Leak Detector Status: Digital Output.
5) Auto/Manual Mode Control: Digital Output.

D. CONTROLS
1. Control components, where specified within this section, shall be provided under this section.
2. The equipment specified under this section shall operate manually/automatically as shown on the drawings and specified in sections 40 9XXX. Any additional materials of equipment required by this section's manufacturer, but not shown on the drawings or specified in sections 40 9XXX, to allow this equipment to function in the required manner, shall be furnished and installed under this section.

3. Provide all miscellaneous supports, brackets, fasteners, and fabrications required to mount and install equipment controls provided under this section.

2.4 PANEL CONSTRUCTION

A. Chemical pump assemblies should be provided on a FRP, PP, or HDPE shelf as shown in the drawings which can be mounted on the floor.

B. Each panel shall include the following:
   1. One (1) shelf for each pump provided, suitable for mounting.
   2. Calibration column(s), with appropriate isolation valves, vent piping, and vent connection, as indicated on the drawings.
   3. Discharge pressure gauge(s), as indicated on the drawings.
   4. Pressure Relief valve(s), as indicated on the drawings. PRVs shall include a sight glass for visual observation if the pump is reliving via the valve.
   5. Back Pressure valve(s), where indicated on the drawings.
   6. Sight gauge(s), for visual indication that chemical is being fed, as indicated on the drawings.
   7. Carrier water solenoid, needle valve, and rotameter, where indicated on the drawings.

C. Maximum Dimensions
   1. Two (2) Pump Panel: 36” x 20” x 48” (W x D x H)
   2. Three (3) Pump Panel: 50” x 20” x 48” (W x D x H)

D. Piping
   1. All pump panel piping shall be PVC Pipe and Fittings (Schedule 80) in accordance with Division 40, Section “Process Piping”. Solvent cement shall be IPS Corporation Weld-On 724, without exception.

E. Valves
   1. All pump panel valves shall be Ball Valve (Thermoplastic) in accordance with Division 40, Section “Process Valves, Gates, and Accessories.” Ball valves shall be Asahi Type 21/21A, without exception.

F. Accessories
   1. Each pump panel shall include the accessories as shown on the drawings, including, but not limited to the following:
   2. Back Pressure (Anti-Siphon) Valves:
      a. Provide back pressure regulating valve(s) where indicated on the drawings. Provide back pressure regulators of polyvinylchloride or CPVC construction, and having Hypalon or Teflon diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Provide spring opposed diaphragms with loading pressures adjustable by means of screw in top works. Field-adjust valves to settings required of the system. Setting to be minimum pressure to occur upstream of the valve, as installed in system, while pump is operating.
      b. Provide materials of construction compatible with the service specified and indicated.
   3. Pressure Relief Valves:

a. Provide pressure valves where indicated on drawings. Provide pressure relief of PVC or CPVC construction, and having Hypalon or Teflon diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Provide spring opposed diaphragms with loading pressures adjustable by means of screw in top works. Field-adjust valves to settings required of the system. Setting to be the maximum pressure to occur downstream of the valve, as installed in system, while pump is operating.

4. Carrier water:
   a. Where indicated on the drawings, provide a connection for carrier water. Piping shall include a solenoid valve, need valve, and rotameter.
5. Calibration Column:
   a. Provide calibration column(s) where indicated on the drawings.
   b. Size for a minimum 30-second draw down at maximum pump speed.
   c. Material: Schedule 40 clear PVC pipe with Schedule 80 fittings.
6. Injection Quill/Nozzle:
   a. Manufacturer:
      (1) Saf-T-Flo EB-146.
      (2) Engineer Approved Equal.
   b. Valve/Process Connection Size: 1-inch
   c. Inlet Connection Size: ½-inch
   d. Solution Tube Size: ½-inch
   e. For each injection point, provide an injection quill/nozzle assembly that is removable without dewatering the process line.
   f. Each quill shall include an integrated check valve. Check valve shall be the spring-loaded ball check type. Refer to the Metering Pump Schedule for the check valve seal material type.
   g. Each quill shall include a flexible hose assembly, provided by the quill manufacturer. Hose size shall be ½-inch and shall be clear braided PVC.
   h. Unions shall be provided for easy removal, refer to drawings for details.
   i. Valve Material: 316 SST
   j. Solution Tube Insertion Length: Refer to the Metering Pump Schedule.
   k. Solution Tube Material: Refer to the Metering Pump Schedule.
   l. Tip Configuration: Refer to the Metering Pump Schedule.

2.5 SHOP TESTING:

A. Motor Test:
   1. Give each motor a standard commercial test in the shop of the motor manufacturer and submit certified copies of the test results to the Engineer for review prior to installation of the motors.

B. Pump Test:
   1. Certified performance testing.
      a. Conduct tests as specified above for full speed at reduced speeds. Run one speed test at speed required to discharge the minimum rating point. Run a second test at a speed approximately midway between full and minimum speed.
      b. Factory tests on pumps must be conducted using the actual job motor and gear reducer.
   2. Run tests in accordance with the latest standards of the Hydraulic Institute, where applicable.

3. Inlet Vacuum Test:
    a. Test assembled pump running on air.
    b. Run test for a minimum of 5 minutes and record vacuum reading which must meet or exceed 95 percent full vacuum.
4. Repeat tests until specified results are obtained.
5. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to Owner.

C. Piping Test:
1. Wet test the entire skid with water to 1.5 times its design operating pressure.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install equipment and appurtenances in accordance with manufacturer's printed instructions, as indicated and specified.

B. Install pumping units on a concrete pad. Assure there is no pipe stress on pump piping connections.

C. All electrical power and control connections shall be furnished under division 26.

3.2 FIELD CALIBRATION AND TESTING:

A. General:
1. Coordinate testing with operation of other portions of the facility. Arrange for temporary piping and wiring modifications which may be needed if chemical cannot be fed at intended dosing points, or if other interconnected electrical equipment is not operational.
2. Calibrate in the presence of the Engineer.
3. After cleaning, completely test each chemical feed system to verify that equipment is capable of performing its specified function in satisfactory manner without mechanical or electrical defects, binding, or operational difficulties. Correct defects and deficiencies and repeat all tests until satisfactory results are obtained. Correct excessive vibration leakage or noise. Make connections watertight or dusttight.
4. Demonstrate accuracy of units and bring within limits specified herein.
5. At the time of the tests, make final adjustments necessary to place equipment in satisfactory working order.
6. Test and calibrate equipment and accessories specified herein in accordance with manufacturer's printed instructions over full operating range of equipment.
7. Water testing is permitted where appropriate for preliminary testing purposes; however, conduct acceptance tests using appropriate chemicals for which each system was designed.
8. Complete preliminary and calibration testing and corrections prior to acceptance testing, as specified herein, to be conducted with the manufacturer's technical representative.
9. Copies of tests to be furnished to the Engineer.
10. Neutralize and dilute chemicals wasted during testing procedures with 10 volumes of water prior to disposal into plant drain system. Direct dumping into drains without prior neutralization and dilution is hazardous and not permitted.
11. Identify any exceptions to specification in documentation.

B. Chemical Pumps (Acceptance Tests):

1. Submit five copies of manufacturer's preliminary and calibration pump curves showing numerical values of pump discharge to nearest tenth of a gallon per hour.
2. Perform testing at 100, 75, 50 and 25 percent of speed settings.
3. Submit individual pump calibration curves to Engineer at least 15 days prior to acceptance testing. Notify Engineer when pumps are ready for acceptance testing, and make no adjustments or modifications to pumps after that time, without written permission of Engineer.
4. During acceptance testing demonstrate correct functioning of control stations.
5. Perform testing in the following manner:
    a. Test pumps by filling calibration standpipe with chemical and measuring time to pump a given volume out of the standpipe, with all other equipment valved off. Make test measurements of at least fifty seconds duration, using two stopwatches reading time to nearest one-hundredth second. Discard measured times differing more than one-half second. Average times differing by one-half second or less. Record averaged time for use in determining acceptability of pumps.
    b. For pumps equipped with back pressure valves, perform testing at the back pressure valve setting of 50 psig.
6. To determine deviation, compare measured pump output at various settings with output indicated by manufacturer's calibration curves. Pumps with deviation greater than plus or minus 3.0 percent of maximum pump output are not acceptable.
7. Add 0.5 percent to the deviation for the acceptance of pumps delivering slurries.
8. If pump output varies excessively, it is possible the pump is air bound. Operate pump for five minutes at back pressure valve setting of 50 psig. Pumps unable to relieve themselves of air within five-minute period are not acceptable.
9. Operate pumps for period of four hours to demonstrate satisfactory operation.

3.3 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.4 CONTRACT CLOSEOUT:

A. Provide in accordance with Division 01, Section “Closeout Procedures”.

END OF SECTION 46 3344

RARWTP METERING PUMP SCHEDULE

A. Sodium Bisulfite ($NaHSO_3$)

1.	Feed Location:	NF Feed (NFF)
2.	Chemical Flowrate:	0.45 to 2.70 gph
3.	Backpressure:	60 psig
4.	Pump Panel:	Two (2) Pumps
5.	Injection Quill:	
a.	Solution Tube Material:	Hastelloy C276
b.	Solution Tube Length:	10-inch
c.	Tip Configuration:	Standard
d.	Check Valve Seal:	EPDM

B. Antiscalant (A.S.)

1.	Feed Location:	NF Feed (NFF)
2.	Chemical Flowrate:	0.41 to 0.83 gph
3.	Backpressure:	60 psig
4.	Pump Panel:	Two (2) Pumps
5.	Injection Quill:	
a.	Solution Tube Material:	Hastelloy C276
b.	Solution Tube Length:	10-inch
c.	Tip Configuration:	Standard
d.	Check Valve Seal:	EPDM

C. Sodium Hypochlorite (NaOCl) - Oxidation

1.	Feed Location:	Raw Water (RW)
2.	Chemical Flowrate:	3.79 to 11.36 gph
3.	Backpressure:	<30 psig
4.	Pump Panel:	Two (2) Pumps

D. Sodium Hypochlorite (NaOCl) - Disinfection

1.	Feed Location:	NF Permeate (NFP) or NF Bypass (NFB)
2.	Chemical Flowrate:	8.15 to 16.31 gph
3.	Backpressure:	<30 psig
4.	Pump Panel:	Three (3) Pumps
5.	Injection Quill (NFP):	
a.	Solution Tube Material:	Hastelloy C276
b.	Solution Tube Length:	8-inch
c.	Tip Configuration:	Standard
d.	Check Valve Seal:	Viton
6.	Injection Quill (NFB):	
a.	Solution Tube Material:	PVC
b.	Solution Tube Length:	6-inch
c.	Tip Configuration:	Standard
d.	Check Valve Seal:	Viton

E. Sodium Hydroxide (NaOH)

1.	Feed Location:	NF Permeate (NFP) or NF Bypass (NFB)
2.	Chemical Flowrate:	2.98 to 11.94 gph
3.	Backpressure:	<30 psig
4.	Pump Panel:	Two (2) Pumps

5. Injection Quill (NFP):
    a. Solution Tube Material: Hastelloy C276
    b. Solution Tube Length: 8-inch
    c. Tip Configuration: Standard
    d. Check Valve Seal: Viton
6. Injection Quill (NFB):
    a. Solution Tube Material: PVC
    b. Solution Tube Length: 6-inch
    c. Tip Configuration: Standard
    d. Check Valve Seal: Viton

F. Fluoride (FLUOR.)
1. Feed Location: NF Bypass (NFB)
2. Chemical Flowrate: 1.65 to 2.69 gph
3. Backpressure: <30 psig
4. Pump Panel: Two (2) Pumps
5. Injection Quill:
    a. Solution Tube Material: PVC
    b. Solution Tube Length: 6-inch
    c. Tip Configuration: Standard
    d. Check Valve Seal: EPDM

G. Corrosion Inhibitor (PHOS.)
1. Feed Location: NF Bypass (NFB)
2. Chemical Flowrate: 1.55 to 4.66 gph
3. Backpressure: <30 psig
4. Pump Panel: Two (2) Pumps
5. Injection Quill:
    a. Solution Tube Material: PVC
    b. Solution Tube Length: 6-inch
    c. Tip Configuration: Standard
    d. Check Valve Seal: Viton

SECTION 46 3393.01

POLYETHYLENE CHEMICAL STORAGE TANKS AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Provide and test plastic chemical storage tanks and appurtenances as indicated and in compliance with Contract Documents.

B. Provide each chemical storage system complete in details and before acceptance make each system fully operational and ready for use by the Owner.

C. Chemical systems to meet:
   1. Recommended Standards for Water Works (2012 edition or the latest revisions), Part 5.

D. Chemical for testing to be supplied by the Contractor in accordance with Division 46, Section "Process Chemicals".

1.2 REFERENCES:

A. American Society of Mechanical Engineers (ASME):
   1. B-16.5: Pipe Flanges and Flanged Fittings

B. ASTM International (ASTM):
   1. D638: Standard Test Method for Tensile Properties of Plastics
   2. D648: Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
   3. D746: Specification for Polyethylene Tank Testing
   4. D790: Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
   5. D883: Definitions of Terms Related to Plastics
   6. D1505: Density by Density Gradient Technique
   7. D1693: Environmental Stress Crack Resistance
   8. D1998: Standard Specification for Polyethylene Upright Storage Tanks

C. Association of Rotational Molders (ARM):
   1. Standard Low Temperature Impact Resistance

D. National Sanitary Foundation (NSF):
   1. 61: Drinking Water System Components - Health Effects

E. National Fire Protection Association (NFPA):
   1. 704: National Fire Rating System (NFR).

F. Occupational Safety and Health Association (OSHA):
   1. 29 CFR Part 1910.27 Fixed Ladder
   2. 29 CFR Part 1926.104 Safety Belts, Life Lines and Lanyards
   3. 29 CFR Part 1926.500 Fall Protection

4. 29 CFR Part 1926.501 Fall Protection
5. 29 CFR Part 1926.502 Fall Protection

G. Uniform Building Code (UBC):
1. Tank Restraints.

1.3 SUBMITTALS:

A. Submit the following in accordance with Division 01, Section “Submittal Procedures”:
1. When the Contractor proposes tanks which requires an arrangement differing from that indicated on the drawings or specified, prepare and submit for review detailed structural, mechanical, and electrical drawings and equipment lists, utilities consumption schedule and operating instructions, showing all necessary changes and embodying all special features of the equipment he proposes to furnish. Make changes, if accepted at no additional cost to Owner.
2. Operating and maintenance instructions and parts lists.
3. Shop drawings data for accessory items.
4. Templates or certified setting plans, with tolerances, for anchor bolts.
5. Number and identify components to correspond with terminology on drawings. Use these numbers on all submittal sheets and shop drawings.
6. Recommendations for short and long term storage.
7. Sales bulletins or other general publications are not acceptable as submittals for review except where necessary to provide supplemental technical data.
8. Provide a listing of the materials recommended for each service specified and indicated.
9. ISO 9000 series certification or other quality control manual demonstrating a complete system for quality management.
10. Tank manufacturers must be capable of providing a list of customers using at least five (5) similar tanks for the same chemical applications for at least ten (10) years.
11. Material Certification:
    a. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of three (3) years. Provide proposed materials at no additional cost to the Owner.
    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
12. Certified results of factory tests.

B. Special Requirements:
1. Manufacturer's specification, catalog data and illustrations.

C. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".
1. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
   1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
   2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in rejection of the entire submittal with no further review and consideration.

1.4 QUALITY ASSURANCE:

A. Do work required by and in accordance with applicable State and local codes; arrange for permits, inspections and tests required by these codes; and provide complete systems ready for use. Provide tanks and accessories that conform to applicable safety standards including those for safety of personnel.

B. Provide components to manufacturer's standard for service intended unless otherwise required.

C. Provide components and accessories of manufacturers' latest and proven design.

D. The drawings and specifications direct attention to certain required features of the tanks, but do not purport to cover details entering into its design, construction and installation; nevertheless, provide tanks so that systems will be complete and ready for operation.

E. Provide supervisory services for satisfactory installation, with factory-trained serviceman to assist in determining location and orientation.

F. Coordinate the work schedule of other parts of the chemical systems manufacturer's service personnel during construction, testing, start-up, and acceptance, to coordinate with the tank manufacturer.

G. Upon completion of the installation, provide services of above serviceman for field testing.

H. Clean tanks internally prior to shipping.

I. Shop test and provide certificates as specified.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Division 01, Section "Product Requirements”.

1.6 WARRANTY

A. Manufactuer shall provide a full 5 year replacement warranty for all tanks.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. General:

1. Tank plans, elevation and data as indicated.
2. Tank data includes pressure, temperature, shell, head, connections, materials, design and construction details along with nozzle information.
3. Provide tanks with lifting lugs for handling and a tie-down system for installation.
4. Provide tank nozzles meeting ASME B16-5, as indicated. Project nozzles at least 4-inches (100 mm) from the tank surface.
5. Provide overflow pipe support brackets on side of tank, to support overflow pipe.
6. Equip tank with an internal support bracket for holding level instrument as specified and all interior piping.
7. Provide spare connections with the specified type of nuts, bolts, gaskets and blind flanges.
8. Clean tanks internally prior to shipment to meet NSF 61. Ship tanks protected to prevent damage to tanks and their protective coatings. Provide open nozzles with masonite or plywood covers.
9. Provide top of tank capable of supporting its equipment, walkway and maintenance personnel.
10. Provide an anchorage point at the top of the storage tank(s), in accordance with OSHA 29 CFR Part 1926.500, 1926.501 and 1926.502.

2.2 TANKS:

1. Manufacturers (Flat Bottom Tanks):
   a. Poly Processing.
2. Manufacturers (Conical Bottom Tanks):
   a. Snyder Industries.
3. Provide High Density Cross-Linked Polyethylene Vertical/Horizontal storage tanks, with all accessories as specified.
4. All tanks shall be fume-tight.
5. The XLPE Tanks shall be as manufactured in accordance with the definitions given in ASTM-D1998 Type I (Standard Specification for Polyethylene Upright Storage Tanks). The tanks shall be manufactured by the rotational molding process.
6. All tanks shall be designed for a specific gravity of 1.90, using a hoop stress value of no greater than 600 psi at 100 degrees F, with a safety factor of no less than 2, using the Barlow Formula for calculating wall thickness. For applications in excess of 100 degrees F design conditions, lower values for the design hoop stress shall be used.
7. The tank shall be molded from a virgin High Density Cross-Linked Polyethylene resin, with no fillers.
8. Impact Test: Shall be done in accordance with ASTM D746. Standard method shall be used in this test.
9. The nominal value for the properties of the polyethylene plastic material shall be as follows, as supplied by the resin suppliers.

Test Procedure	Units	XLPE	HDPE
Density/ASTM D1505	g/cc	0.940 to 0.945	0.939
ESCR Cond. A, F50/ASTM D1693 10 Percent Igepal	Hrs.	>1000	1000
Tensile Strength/ASTM D638	psi	2,600	3,900
Flexural Modulus/ASTM D790	psi	1000,000 to 110,000	86,500
Heat Distortion Tem./ASTM D648 At 66 psi	Degrees C	67 Degrees	-
Long Term Hydrostatic (LTHS) (Creep)	psi	900	-
FDA-grade resin	-	No	Yes
UV-stabilized	-	Yes	Yes

10. The tanks shall be designed for 1.9 Specific Gravity using a hoop stress value of no greater than 600 psi at 100 degrees F, with a safety factor of no less than 2, using the Barlow Formula for calculating wall thickness. For applications in excess of 100 degrees F design conditions, lower values for the design hoop stress shall be used.
11. Where indicated, resin shall include an additional medium density polyethylene (OR-1000) liner with four times the antioxidant properties of a standard polyethylene bonded to the interior surface during the manufacturing process.
12. All edges cut out for manway or other openings shall be trimmed to have smooth edges.

B. Fittings
   1. Bulk Tanks
      a. Lower sidewall connection: Day tank fill line connections to bottom of bulk tanks shall be integrally molded flanged outlet type connections. The connection shall be an integral part of the tank, molded from the same materials as the tank, and located flush with the tank bottom to provide complete drainage of liquid through the sidewall of the tank. Inserts are not permitted. Bolted flange shall be constructed of one 150 lb ANSI pattered flanged and flanged gasket. Stud bolts shall have encapsulated chemical resistant injection molded polyethylene heads and include gaskets to provide a sealing surface between the bolt and and the inerior tank wall.
      b. All other sidewall connections: All other sidewall connections to bulk tanks shall be bolted one-piece sure seal (B.O.S.S.) double flanged fittings constructed of polyethylene. Bolts shall we welded to a backing ring and be encapsulated in polyethylene.
      c. All dome connections: All connections to the dome of the bulk tanks shall be PVC self-aligning bulkhead type.
   2. Day Tanks
      a. All sidewall connections: All sidewall connections to bulk tanks shall be bolted one-piece sure seal (B.O.S.S.) double flanged fittings constructed of polyethylene. Bolts shall we welded to a backing ring and be encapsulated in polyethylene.
      b. All dome connections: All connections to the dome of the bulk tanks shall be PVC self-aligning bulkhead type.
   3. Coordinate fittings with connected instruments.

2.3 MATERIALS OF CONSTRUCTION:

A. All fittings, gaskets, and bolts on chemical feed piping and accessories shall be as follows. Liners shall be provided as indicated.

Chemical	Liner	Fitting Material	Gasket Material	Bolt Material
Sodium Bisulfite ($NaHSO_3$)	NA	SCH 80 PVC	EPDM	316 SST
Antisclant (A.S.)	NA	SCH 80 PVC	EPDM	316 SST
Sodium Hypochlorite (NaOCl)	OR-1000	SCH 80 PVC	Viton	Titanium
Sodium Hydroxide (NaOH)	NA	SCH 80 PVC	EPDM	316 SST
Corrosion Inhibitor (PHOS.)	NA	SCH 80 PVC	Viton	Hastelloy C-276
Fluoride (FLUOR.)	NA	SCH 80 PVC	Viton	Hastelloy C-276
MCS/Permeate Flush Tanks	NA	SCH 90 PVC	EPDM	316 SST

2.4 TANK ACCESSORIES:

A. Flexible Expansion Joints:
   1. Provide expansion joints where indicated on the drawings to allow the tank to expand and contract when filling and draining.
   2. Bulk Tank Sidewall Connections:
      a. Provide PolyProcesscing FlexiJoint Expansion Joint (or Engineer approved equal) at these locations. Joint shall be a flexible PTFE connector desiged to compensate for misalignment, absorb expanions and contraction, and isolate vibration and shock. Joint shall be made of 100% virgin PTFE resin. Flanges shall be CPVC. Bolts and gaskets shall be per the materials of construction table in this specification section.
   3. Day Tank Top Connections:
      a. Provide Synder Flexmaster (or Engineer approved equal) flexible fitting connector at these locations.

B. Bolted Sealed Top Manway:
   1. Provide sealed manway for all bulk tanks. Manways shall be constructed of polyethylene material. The bolts and gaskets shall be as specified under the materials of construction. Manways shall seal fume-tight.

C. Anti-foam Assembly:
   1. Provide anti-foam elbow assemblies at fill connections for all bulk tanks. Assembly shall consist of a 45 degree elbow and nipple extending to within 3-inches of the tank wall to direct liquid smoothly down the interior surface of the tank.

D. Overflow Piping:
   1. Overflow pipes shall etended into manufacturer provided 5 gallon buckets. Piping shall be installed such that the bucket can be removed if needed. Contractor shall ensure that buckets are filled with water prior to chemical being added to tanks.

E. Reverse float level indication:
   1. A reverse float level indicator shall be provided on all bulk storage tanks. The indicator shall act inverserly to the tank contents and shall not allow tank contents into exterior site

tube. The indiactor shall include a PVC float, neon orange indicator, polypropylene rope, 4-inch interior perforated pipe, PVC roller guide elbwos, a 2-inch clear UV resistant PVC sight tube, and all required pipe supports.

F. Ladders:
1. Rigid FRP ladder with cage and return to be provided on each bulk tank (ladders are not shown on drawings for clarity).
2. Ladders to be in accordance with OSHA 29 CFR Part 1910.27, Fixed Ladder.
3. Provide with a ladder safety device conforming to OSHA 29 CFR Part 1910.27 for ladders above six feet in height. Provide one personnel full body harness in conformance with OSHA 29 CFR Part 1926.104 and associated attachments for every two tanks provided. Ladder safety device shall be provided in addition to any cage or landing required or shown.
4. Ladder rungs to be nonskid of fiberglass on one foot centers, two foot wide.

G. Stands (for conical bottom tanks)
1. Stands shall be provided for conical bottom tanks. Stands shall be designed and certified by a structural engineer registered in the United States. Design shall conform to the most recent edition of the IBC code for seismic winds and loads.
2. Material: 304 SST

2.5 TANK SIGNAGE:

A. Provide signage for identifying for the chemicals contained in the tanks.
1. Provide two (2) signs per tank. Location to be determined in the field by the Engineer for proper visibility.
2. Letters to be 6-inches high, colors of letters and background to be submitted for acceptance. Signs to be vinyl and screen printed and UV resistant inks. No mechanical fasteners are allowed.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install tanks in accordance with printed instructions of fabricators, as indicated and specified.
1. Do not use fittings for handling.
2. Install on concrete pads.
3. Provide pad as recommended by the tank supplier.
4. Assure there is no stress on tank nozzles.

3.2 FIELD PAINTING:

A. Specified in Division 09, Section “High Performance Coatings”.

3.3 ACCEPTANCE TESTING:

A. Tanks:
1. Supply all pipe, hose, pumps, water, power and other equipment required to convey the test liquids and carry out the tests.
2. After installation, clean tanks of loose debris and dry prior to tests.

3. Test tanks for leaks or damage prior to use. Certification to ASTM D-1998.
4. Test tanks with water first and then with specified chemical.
5. Do not test acid tanks with water; use air at pressure of 5 psig for one hour prior to test with acid.
6. Test tanks with each liquid for period of 24 hours during which no visible leakage is acceptable.
7. Where hydrostatic testing of tanks is specified, apply required hydrostatic test pressure in addition to pressures imposed by filling tank with required liquid. In order to simulate these conditions, attach standpipe to top of tank, and fill tank and standpipe assembly with water. Measure height of standpipe above highest point of tank. Provide standpipe of height equal to height of tank times difference between specified gravity of required liquid and specific gravity of water, plus additional height equal to hydrostatic test pressure specified. Leakage during four hour test not acceptable.
8. Repair leaks or damage by tradesman skilled in that type of work at no cost to the Owner.

3.4 CONTRACT CLOSEOUT:

A. Provide in accordance with Division 01, Section “Closeout Procedures”.

END OF SECTION 46 3393.01

RARWTP TANK SCHEDULE

A. Sodium Bisulfite ($NaHSO_3$)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): 100 gal
      c. Diameter (max): 1’-11”
      d. Height (max): 5’-7”
   2. Bulk Tank
      a. Quantity: Two (2)
      b. Volume (min): 2,750 gal
      c. Diameter (max): 8’-2”
      d. Height (max): 9’-3”

B. Antiscalant (A.S.)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): 30 gal
      c. Diameter (max): 1’-11”
      d. Height (max): 2’-2”

C. Sodium Hypochlorite (NaOCl)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): 685 gal
      c. Diameter (max): 5’-1”
      d. Height (max): 5’-4”
   2. Bulk Tank
      a. Quantity: Three (3)
      b. Volume (min): 6,100 gal
      c. Diameter (max): 10’-0”
      d. Height (max): 12’-8”

D. Sodium Hydroxide (NaOH)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): 280 gal
      c. Diameter (max): 2’-10”
      d. Height (max): 7’-1”
   2. Bulk Tank
      a. Quantity: Two (2)
      b. Volume (min): 3,000 gal
      c. Diameter (max): 7’-1”
      d. Height (max): 12’-0”

E. Corrosion Inhibitor (PHOS.)
   1. Day Tank
      a. Quantity: One (1)
      b. Volume (min): 155 gal
      c. Diameter (max): 2’-7”
      d. Height (max): 4’-9”

2. Bulk Tank
    a. Quantity: Two (2)
    b. Volume (min): 3,000 gal
    c. Diameter (max): 7’-1”
    d. Height (max): 12’-0”

F. Fluoride (FLUOR.)
1. Day Tank
    a. Quantity: One (1)
    b. Volume (min): 60 gal
    c. Diameter (max): 1’-11”
    d. Height (max): 3’-6”
2. Bulk Tank
    a. Quantity: Two (2)
    b. Volume (min): 1,150 gal
    c. Diameter (max): 5’-4”
    d. Height (max): 8’-6”

G. Membrane Cleaning System (MCS)
1. Stage 1- Conical Bottom, Closed-top
    a. Quantity: One (1)
    b. Volume (min): 3,600 gal
    c. Diameter (max): 8’-6”
    d. Height (max): 11’-3”
2. Stage 2- Conical Bottom, Closed-top
    a. Quantity: One (1)
    b. Volume (min): 2,500 gal
    c. Diameter (max): 7’-11”
    d. Height (max): 10’-5”

SECTION 46 4117

INLINE STATIC MIXERS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section.

1.2 DESCRIPTION OF WORK

A. Provide and install in-line static mixers, where indicated on the drawings and specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Division 40 Section “Process Piping”.

B. Division 40 Section “Process Valves, Gates, and Accessories”.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications
   1. Static Mixers shall be the product of one manufacturer
   2. Static Mixers shall be the Manufacturer’s standard product.
   3. The Manufacturer shall have been engaged in the production of the type of equipment being provided for the past five years.

B. Conform to the requirements of Division 01, General Requirements
   1. Manufacturer’s field services, if applicable, should be provided at no additional cost to the Owner.

1.5 SUBMITTALS

A. Provide technical submittals in accordance with Division 01 Section “Submittal Procedures”, demonstrating that all equipment provided conforms to the requirements.

B. Shop Drawings and Product data:
   1. Manufacturer's catalog information, descriptive literature, specifications and identification of materials of construction by ASTM reference and grade.
   2. Dimensional drawings and installation details.
   3. Operation and Maintenance Manual. O&M Manuals shall be in accordance with Division 01, Section “Operation and Maintenance Data”.

1.6 SPARE PARTS (NOT REQUIRED)

1.7 HANDLING, DELIVERY, AND STORAGE

A. Handling, delivery, and storage of the static mixing equipment shall be in compliance with the manufacturer's written instructions.

B. All equipment and parts shall be properly protected against any damage during storage at the site. Static mixers shall be stored in a dry sheltered environment, protected from weather.

PART 2 - PRODUCTS

2.1 MIXER DESIGN

A. The static mixers shall be of a compact ring body design for mounting between two standard pipe flanges.

B. The mixers shall be the static in-line orifice type for turbulent mixing with no moving parts. The mixer shall produce homogeneous mixing, blending, and dispersion of chemical in water.

C. Chemical injection points shall be provided upstream of the mixer per the injection quill detail on the drawings. Chemical injection quills are provided under Division 46, Section "Chemical Peristaltic Metering Pumps and Appurtenances." As an alternative, the mixer may be fitted with connections for the injection of chemical directly into the mixer body. If this option is chosen, General contractor shall coordinate mixer layout to ensure injection quills can be easily removed.

D. Manufacturers
   1. Kenics
   2. Westfall Mfg.
   3. Komax

E. Provide and install a 316 stainless steel nameplate on each static mixer with the following information as a minimum:
   1. Manufacturer.
   2. Model number.
   3. Design conditions.
   4. Number of mixing elements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install mixers as indicated on the drawings and in accordance with the Manufacturer's recommendations.

B. Install mixers in a clean condition, free of dirt, chemical residue, or other deleterious substances.

C. Pigging of the static mixer is prohibited.

END OF SECTION 46 4117

RARWTP MIXER SCHEDULE

A. NF Feed (NFF)
   1. Pipe Size: 30-inches
   2. Ends: Suitable for flanged pipe, provide adaptor flange on one end
   3. Flow range: 1.8 to 17.5 MGD
   4. Working Pressure: < 100 psi
   5. Working Temperature: 55 Deg F +/-
   6. Body Ring: 316 SST
   7. Mixer Plate: Hastelloy C-276
   8. Gasket: Viton
   9. Chemicals: Antiscalant, 38% Sodium Bisulfite
   10. Beta Value: 0.7

B. NF Bypass (NFB)
   1. Pipe Size: 16-inches
   2. Ends: Suitable for flanged pipe, provide adaptor flange on one end
   3. Flow range: 0.8 – 8.0 MGD
   4. Working Pressure: < 30 psi
   5. Working Temperature: 55 Deg F +/-
   6. Body Ring: 316 SST
   7. Mixer Plate: Hastelloy C-276
   8. Gasket: Viton
   9. Chemicals: 23% Fluoride, 50% Sodium Hydroxide, 29% Orthophosphate, 12.5% Sodium Hypochlorite
   10. Beta Value: 0.8

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SECTION 46 6320

CARTRIDGE FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes furnishing and installation of all a complete cartridge filtration systems as shown on the drawings for pretreatment of the NF feed water. The cartridge filter housing shall be either stainless steel (SST) or fiberglass reinforced plastic (FRP).

1.3 QUALITY ASSURANCE

A. The manufacturers of the equipment specified under this section shall be a standard product of a Manufacturer who has been regularly engaged in the production of the equipment for a minimum of five years. The cartridge filter assemblies shall be of proven ability and shall be designed, constructed, and installed in accordance with best industry procedures and methods.

B. The owner requires that all cartridge filters on the entire job shall be from the same manufacturer.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 General Requirements.

B. Submit to the Engineer for approval, in accordance with the Contract Documents, shop drawings for the equipment to be furnished under this Section. The shop drawings shall include at least the following:
   1. Certified shop and erection drawings showing all details of construction, dimensions, and anchor bolt patterns.
   2. Descriptive literature and drawings, including parts list, bulletins and/or catalog cuts for the equipment, including all accessories, with the items to be furnished clearly marked in the submittal material.
   3. A list of the Manufacturer’s recommended spare parts, including gaskets and hardware.
   4. Make, model, and weight of each assembly.
   5. Headloss vs. flow projection throughout the operating ranges.
   6. Special shipping, storage and protection, and handling instructions.
   7. Manufacturer’s written/printed installation instructions.

C. Submit for the Engineer’s review the following:
   1. Routine maintenance requirements prior to plant startup.
   2. Operation and Maintenance manuals. O&M Manuals shall be in accordance with Division 01, Section “Operation and Maintenance Data”.

1.5 SPARE PARTS

A. Filter O-Rings: Supply one spare ethylene propylene rubber O-ring per cartridge filter pressure vessel.

B. Filter Elements: Supply two (2) complete replacement sets of filter elements for each vessel in addition to one (1) initial set (3 sets total).

1.6 HANDLING, DELIVERY, AND STORAGE

A. The cartridge filter shall be completely factory assembled, aligned, and securely crated for shipment.

B. When received at the site, the cartridge filter shall be stored in its shipping container until ready for installation.

C. When received at the site, the pressure vessels shall be stored in a clean, dry environment until ready for installation.

PART 2 - PRODUCTS

2.1 GENERAL

A. The vessels will filter chemically conditioned water with a pH between 2.0 and 12.0 and could have a Chlorine residual of up to 3 ppm.

2.2 OPTION NO. 1: STAINLESS STEEL CARTRIDGE FILTER VESSELS (SST)

A. General
1. Filter vessels shall be designed and constructed in accordance with OSHA code and ASME Boiler and Pressure Vessel Code Section VIII, Division I. The vessels shall be stamped and National Board registered. The vessels shall have a stainless steel nameplate stamped with the filter model number, the quantity and number of filter cartridges and the equipment number. The vessels shall be designed for use with cartridges that are of common size available from at least two or more manufacturers.
2. Cartridge Filter vessels shall be aligned horizontally and be constructed as generally shown on the drawings.
3. Exterior Finish on vessel: Pickeled and passivated.

B. Materials
1. Filter Vessel: 316L stainless steel.
2. Internal non-removable parts: 316L stainless steel.
3. Removable non-welded internal parts: 316 stainless steel.
4. External attachments welded to the vessel: 316 stainless steel.
5. All removable external parts including but not limited to the closure bolts and the cover davit assembly: 316 stainless steel.
6. Closure bolts, pivot pins, washer, and retaining pins: 316 stainless steel.
7. Hex nuts used on stainless steel bolting: Silicon bronze, aluminum bronze roll threaded nuts or xylan-coated steel nut.
8. Cover davit bushings: Bronze.
9. Compression Springs and Sealing Components: 316 stainless steel.

10. Vessel support legs: 316 stainless steel.

C. Design
1. Construction: Retaining plates welded in the domed cover shall have an access opening to allow for flushing behind the plate to prevent build-up of foreign matter. The closure bolt sets are to include four longer bolts to engage the cover before compressing the cartridge seal springs. The closure is to be designed for the proper number of stainless steel bolts sufficient for the design pressure rating.
2. Cartridge Supports: The bottom cartridge seat shall be a dual purpose type that will accept either double open end or 2-222 O-ring style cartridges. Guide posts are to be of 20 gauge material tri-fold type with no sharp edges or projections. Top seat spring assembly shall be provided for use with double open end cartridges.
3. The cover O-ring groove is to be a single dovetail-type to retain the O-ring in place during opening and closing of the cover.
4. Horizontal filter vessels are to have a removable internal cartridge alignment support plate located in a manner to prevent cartridge movement. If double open end cartridges are utilized, the spring assemblies must have extensions or supports to keep them in place prior to closing the cover.
5. Coordinate with manufacturer on the number of air release valves per cartridge filter.

D. Cartridge filter assembly (pressure vessel with elements) shall have a maximum clean element pressure differential of 2 psi at maximum flow rate.

E. Manufacturer
1. Fil-Trek.
2. Parker Hannafin.

2.3 OPTION NO. 2: FRP CARTRIDGE FILTER VESSELS (FRP)

A. General
1. Filter vessels shall be designed and constructed in accordance with OSHA code and ASME Boiler and Pressure Vessel Code Section X. The vessels shall be stamped and National Board registered. The vessels shall have a stainless steel nameplate stamped with the filter model number, the quantity and number of filter cartridges and the equipment number. The vessels shall be designed for use with cartridges that are of common size available from at least two or more manufacturers.
2. Cartridge Filter vessels shall be aligned horizontally and be constructed as generally shown on the drawings.

B. Materials
1. Filter Vessel: FRP.
2. Internal non-removable parts: FRP.
3. Removable non-welded internal parts: FRP.
4. External attachments attached to the vessel: FRP.
5. Lifting arm (hoist): 316 stainless steel.
6. Closure bolts, pivot pins, washer, and retaining pins: 316 stainless steel.
7. Hex nuts used on stainless steel bolting: Silicon bronze, aluminum bronze roll threaded nuts or xylan-coated steel nut.
8. Main body gaskets: EPDM
9. Vessel support legs: 316 SST.

C. Design
   1. Construction: Retaining plates welded in the domed cover shall have an access opening to allow for flushing behind the plate to prevent build-up of foreign matter. The closure bolt sets are to include four longer bolts to engage the cover before compressing the cartridge seal springs. The closure is to be designed for the proper number of stainless steel bolts sufficient for the design pressure rating.
   2. Cartridge Supports: The bottom cartridge seat shall be a dual purpose type that will accept either double open end or 2-222 O-ring style cartridges. Guide posts are to be of 20 gauge material tri-fold type with no sharp edges or projections. Top seat spring assembly shall be provided for use with double open end cartridges.
   3. The cover O-ring groove is to be a single dovetail-type to retain the O-ring in place during opening and closing of the cover.
   4. Horizontal filter vessels are to have a removable internal cartridge alignment support plate located in a manner to prevent cartridge movement. If double open end cartridges are utilized, the spring assemblies must have extensions or supports to keep them in place prior to closing the cover.

D. Cartridge filter assembly (pressure vessel with elements) shall have a maximum clean element pressure differential of 2 psi at maximum flow rate.

E. Manufacturer
   1. Piedmont

2.4 FILTER ELEMENTS

A. The filter elements shall be spiral wound fiber elements rigid, high-strength, cylindrical cartridges constructed from polypropylene microfibers which have a five (5) micron removal at a nominal 90% efficiency rating.
   1. Support layers and end caps shall be polypropylene. O-Rings shall be Buna-N.
   2. The filter elements used in all vessels in all systems shall be identical.
   3. Nominal OD: 2.5-inch
   4. Length: 40-inch
   5. The initial clean pressure drop shall be less than 4 psig, with the cartridge filter flowing at its rated capacity as measured between the inlet and outlet nozzles.
   6. The maximum pressure drop at exhaustion of the elements (at maximum dirty element headloss condition) shall be less than 30 psig, with the cartridge filter flowing at its rated capacity, as measured between the inlet and outlet nozzles.
   7. Provide two complete sets of elements for each vessel.

B. Manufacturer
   1. Parker Hannifin
   2. Vorex
   3. Engineer approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer’s printed instructions.

3.2 START-UP AND TESTING

A. Conform to the requirements of Division 1 Section “Quality Control”, paragraph 1.8, Manufacturer's Field Services.

B. Follow the manufacturer's recommended procedures for testing, adjusting, and placing of equipment into proper operation.

C. After installation, conduct pressure and leakage tests for each unit as part of the piping tests for the pipe sections where the cartridge filters are installed in accordance with Division 40 Section “Process Piping”.

D. Pressure test according to the requirements of ASME Section VIII.

E. Provide at least one (1) qualified field representatives to be on-site to coordinate and supervise the installation (1 day), startup and testing (1 day) of the Cartridge Filters.

END OF SECTION 46 6320

RARWTP CARTRIDGE FILTER HOUSING SCHEDULE

A. NF Feed Cartridge Filters

1.	Number of units:	4
2.	Operating Pressure:	100 psi
3.	Maximum flow per 40” element:	14 gpm
4.	Design Flow:	2,547 gpm each
5.	Connections:	As shown on the drawings
6.	Orientation:	Horizontal

B. MCS Cartridge Filters

1.	Number of units:	1
2.	Operating Pressure:	100 psi
3.	Maximum flow per 40” element:	14 gpm
4.	Design Flow:	1,080 gpm each
5.	Connections:	As shown on the drawings
6.	Orientation:	Vertical

SECTION 46 6340

NANOFILTRATION MEMBRANE EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. OEM and Contractor Scope
   1. The OEM's scope shall include all work after the inlet flange connection on the skid and shall end at the flanged connections for the permeate, concentrate, and cleaning connections after the various control, isolation, and block and bleed valves. NF feed pumps will be provided by Contractor (off-skid).

B. The system provided under this specification shall be complete and operable in all respects including, but not limited to connections to other systems and facilities, component and system tests, calibration, alignment, and adjustments as necessary to place the system in operation to perform its intended function.

C. The Contractor shall coordinate scheduling, delivery, and shall unload, store, protect equipment, and install the equipment.

D. Connections of electrical, control, and instrumentation components shall be furnished and installed as specified in Division 26 and 409XXX.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Division 09, Section "High Performance Coatings."

B. Division 26—Electrical.

C. Division 40—Process Integration.

1.4 QUALITY ASSURANCE

A. The skid components shall be manufactured from all new materials and equipment.

B. The Owner and/or Engineer shall be provided access at any time to inspect or observe all equipment prior to shipment to the site.

C. All valves, actuators, flow meters, and instrumentation shall be of the same type and from the same manufacturer.

1.5 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 General Requirements.

B. Manufacturer shall submit P&IDs for all equipment furnished under this section to the Engineer for approval, prior to submittal of shop drawings. Once P&IDs have been approved, Manufacturer shall submit shop drawings to the Engineer for approval, in accordance with the Contract Documents, for equipment furnished under this section.

C. Manufacturer's product data including but not limited to valves pressure vessels, end assembly, piping, couplings, membrane elements, instrumentation, controls, and electrical components. Data sheets shall include materials of construction for all hardware used to assemble the skids.

D. Submit process design information detailing the number of stages, number of pressure vessels per stage, flux rate per stage and for the entire membrane train, design feed pressures, design product water quality parameters (based on the projected feed water quality), number of membrane elements per pressure vessel, general information on the proposed membrane element, specific instructions on membrane train construction based on membrane system configuration, piping plan and sections, wiring plan, wiring diagram, control panel layout, sample panel layout, and other relevant information.

E. Assembly and installation drawings including arrangement, layout, and dimensions of all components of the membrane trains, including the control panel, sample panel, piping connections and membrane element loading sequence.

F. Factory acceptance testing results.

G. The OEM's printed instructions for the handling, delivery, storage, and installation of the membrane system components.

H. Operations and Maintenance (O&M) Manual
   1. The OEM shall prepare a comprehensive operation and maintenance (O&M) manual for the system specified as part of this Contract. The manual shall include information on the operation and maintenance of the individual components of the system, and on the operation of the overall package. O&M Manual shall be in accordance with Division 01, Section "Operation and Maintenance Data".

I. The OEM shall also provide personnel training prior to startup, and field assistance during the system checkout, startup, and commissioning.

1.6 SPARE PARTS

A. Provide two spare grooved-end, flexible-type coupling assemblies for each size and type supplied on the membrane skid assembly.

B. Provide two pressure vessel repair kits, consisting of all O-rings and seals and clips required for the rebuilding of one end closure assembly.

C. Provide four permeate orifice plugs, sized to simulate hydraulic design of the membranes.

1.7 HANDLING, DELIVERY, AND STORAGE

A. The OEM shall fabricate and deliver all components of the NF System to the site.

B. All components shall be properly crated and stored at the job site until ready for installation. All components shall be kept clean, dry, and protected from freezing.

C. Weight, handling instructions, type of storage required, and instructions for protective maintenance during storage shall be included with each shipment to the job site.

1.8 WARRANTY

A. The membrane manufacturer shall guarantee the membrane performance as specified herein during the performance warranty period as described below:
   1. Performance Warranty Period: 1 year full warranty plus 2 additional year warranty pro-rated.

B. If the performance requirements specified (permeate water quality and feed pressure) are not met the OEM shall replace all membranes at no cost to the Owner until the requirements are met.

C. Performance Requirements:
   1. Performance Requirements are included in the NF Membrane Equipment Schedule.

PART 2 - PRODUCTS

2.1 GENERAL

A. NF Skid design information and dimensions are included the NF Membrane Equipment Schedule.

B. Membranes
   1. Provide interconnectors, O-rings, and brine seals required for installation in specified pressure vessels. Elements shall be non-telescoping, non-flexing, and leak-free.
   2. Spiral Wound Thin-Film Composite.
   3. Nominal Diameter: 8 inches.
   4. Nominal Length: 40 inches.
   5. Nominal Active Membrane Area: 400 square feet.
   6. Seal Materials: Brine seals and O-rings shall be manufactured from EPDM.
   7. Feed Brine Spacer Thickness: 34 mil.
   8. Manufacturer/Model:
      a. DOW/NF90.

C. Manufacturers
   1. Nanofiltration membrane equipment supplier is currently being determined by the Engineer. Selected supplier and pricing will be provided to the Contractor via addendum.

2.2 SKID ASSEMBLY

A. Material
   1. Base Bid: Epoxy Coated Carbon Steel or FRP
   2. Alternate Bid: 304 SST

B. Frame/Supports
   1. Fabricate frame and supports using material as noted above.
   2. If onsite erection or assembly of the frames is required, OEM shall certify that the skids have been constructed correctly.
   3. All other supports and hardware on the skids shall be either 304 SST or FRP.
   4. Frames shall be designed and stamped by registered professional engineer, and all calculations submitted in accordance with Division 1 Section “Submittals”.

C. Anchor Bolts
   1. Contractor shall provide 316 SST expansion bolts to anchor the skid to the equipment pad below. OEM to coordinate with Drawings to determine anchor bolt locations.

D. Accessories
   1. Locate control panel, sample panel, pressure transmitters, flow transmitters, conductivity meters, and other instruments for each skid where indicated on the drawings, and no less than 2.5 feet no more than 5 feet above floor level.

2.3 FEED, INTERSTAGE, CONCENTRATE, AND PERMEATE PIPING

A. All high pressure feed, interstate, and concentrate piping shall be 316 stainless steel, schedule 10S conforming to the requirements of Division 40, Section “Process Piping.”
   1. All stainless steel piping associated with the membrane skid shall be stress relieved and passivated. Passivation shall be continued to a bright metal finish.
   2. All stainless steel piping shall be thoroughly cleaned inside and out, disinfected, and all scale and welding slag removed.
   3. All piping shall be designed for a working pressure no less than the shutoff head of the NF Feed Pumps being provided (OEM to coordinate with Contractor and NF Feed Pump Supplier).
   4. All stainless steel spool pieces shall be pressure tested to 1.5 times the rated working pressure of the pipe. Pressure testing shall conform to the requirements set forth in Division 40 Section “Process Piping”. Cut or roll-groove as appropriate to the pipe material, wall thickness, pressure, size, and method of joining. Use Victaulic “RX” rolls for grooving Schedule 10 stainless steel pipe.

B. All other piping shall be Schedule 80 PVC conforming to the requirements of Division 40, Section “Process Piping.”

C. Vessel Connections
   1. Feed, Interstage, and Concentrate Connections: Side-ported pressure vessels shall be directly connected to their respective manifolds using grooved-end flexible pipe couplings.

D. Grooved-End Flexible Pipe Couplings
   1. Housings: 304 SST
   2. Gaskets: EPDM rubber, suitable for hot and cold water service.
   3. Bolts / nuts: Round head, square neck, type 316 SST bolts and heavy hex type 316 SST nuts. Washers shall be heavy pattern 316 SST.
   4. Pressure Rating
      a. < 2-inches: 600 psi.
      b. 2-inches and larger: 300 psi.
   5. Manufacturer: Victaulic Style 489, Piedmont Style K, or Engineer Approved Equal.

a. All grooved components shall be of one manufacturer. Installation shall be in strict accordance with the coupling manufacturer's latest published instructions.

E. OEM shall carefully review drawings for coordination on skid connection locations. Skid connection locations have been located for coordination with the Architectural and Structural Layout of the Building. Alternate connection points may not be acceptable. No additional costs will be paid by the Owner for piping revisions that are required for alternate connection points.

F. Manifolds and piping shall be securely supported from the vessel support structure. Manifold support stanchions that are welded to the manifold must be the same material and finish as the manifold. For side-ported pressure vessels, provision must be made for either the feed or concentrate manifold of each stage to allow for movement of the manifold with the vessel side ports as vessel length expands under pressure. Manifolds shall not rely upon mechanical-type coupling joints to support coupled sections of manifolds.

2.4 SIDE PORTED PRESSURE VESSELS

A. Pressure vessels shall be as specified in Division 46 Section "Side Ported Pressure Vessels".

2.5 VALVES

A. Valves and actuators shall conform to the requirements of Division 40 Section "Process Valves, Gates and, Accessories."

2.6 INSTRUMENTATION

A. Flow Measurement
   1. Magnetic Flowmeters
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments."
   2. Paddlewheel Flowmeter
      a. Manufacturer/Model: Seametrics IP800 Series or Engineer Approved Equal.
      b. Materials: Cast Aluminum housing, PVC sensor, Viton O-ring, PVDF rotor, and Kynar shaft.
      c. Features: 4-20 mA output, loop powered.

B. Pressure Measurement
   1. Pressure Transmitters and Switches
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   2. Pressure Switches
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   3. Pressure Gauges
      a. In accordance with Division 40, Section "Process Valves, Gates, & Accessories".

C. Analyzers
   1. ORP
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   2. Conductivity
      a. In accordance with Division 40, Section "Primary Sensors and Field Instruments".
   3. Temperature
      a. Moore Industries TDZ with D2LC housing or Engineer Approved Equal.

2.7 SAMPLE PANEL

A. There shall be a sample panel on each skid made of HDPE or FRP. The panel shall be mounted with corrosion resistant clamps (316 SST) similar to those used to attach the pressure vessels to the support structure.

B. The sample panel shall be fitted with angle-pattern, 1/4-inch-turn, black PVC valves, installed to panel with Swagelock backhead tube fitting SS-400-71-4 for 1/4-inch OD tubing or Engineer Approved Equal.

1. There shall be one sample valve for the permeate for each pressure vessel on the skid, plus valves for 1st stage feed, interstage, concentrate, 1st stage total permeate, 2nd stage total permeate, and total permeate. Provide a label for each sample valve corresponding to the location from which the sample is drawn.

C. The sample panel shall be equipped with a 6-inch deep x 6-inch wide trough for each row of sample valves, of the same material as the panel, which shall be drained by a 2-inch PVC pipe. Route drain pipe to trench drain located beneath each skid as shown on the drawings. Provide slope in trough to properly drain sample water. Provide adequate clearance for a one-gallon milk jug between the sample valves and the trough.

D. Sample tubing shall be 1/4-inch OD polyethylene, with a minimum working pressure of 300 psi at 75 deg F. Sample tubing shall be black. Tubing shall be Manufactured by Imperial Eastman Division, Imperial Clevite, Inc., or Engineer Approved Equal.

E. Tubing shall be neatly arranged and bundled where possible. Bundles shall be retained with nylon tywraps, or grouped in PVC conduit with properly arranged openings for tubing. Label sample taps according to stage and sequential number.

2.8 WET PANEL

A. A Wet Panel shall be provided for each skid made of HDPE or FRP board, floor-mounted where indicated by the Drawings, adjacent to each skid. The panel shall be mounted on FRP supports with corrosion resistant (316 SST) clamps similar to those used to attach the pressure vessels to the support structure. The Skid Wet Panel may be combined with the Skid Sample Panel.

B. The Wet Panel shall incorporate all instrumentation and control components local to each train except for those that must be installed inline, or otherwise indicated in the PID drawings. The panel shall include pressure gauges, transmitters, indicators, analytical instruments, and other components indicated on the Drawings. The panel shall consist of a flat panel for gauges, analytical sensor cells, and other surface mounted components; a NEMA 4X enclosure for mounting analytical transmitters, electronic displays, and components.

C. Skid shall include drain piping from the wet panel to the trench drain beneath each skid as shown on the drawings.

2.9 MCS SYSTEM

A. MCS Tanks(s)

1. MCS Tank(s) are specified in Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances". These tanks to be provided by the Contractor. OEM to coordinate with Contractor and MCS Tank Supplier.

B. Piping
1. MCS Piping is specified in Division 40 Section "Process Piping". MCS piping shall be provided and assembled by the Contractor. Skidded MCS systems are not acceptable.

C. Valves
1. MCS valves are specified in Division 40, Section "Process Valves, Gates, and Accessories". MCS valves shall be provided by the Contractor. OEM to coordinate with Contractor and MCS Valve Supplier.

D. Pump(s)
1. MCS Pump(s) are specified in Division 43, Section "Horizontal End Suction Pumps". These pumps shall be provided by the Contractor. OEM to coordinate with Contractor and MCS Pump Supplier.

E. Cartridge Filter Housing(s)
1. MCS Cartridge Filter Housing(s) are specified in Division 44, Section "Cartridge Filters and Appurtenances". Cartridge filter housing(s) shall be supplied by the Contractor. OEM to coordinate with Contractor and Cartridge Filter Housing Supplier.

F. Instrumentation/Accessories
1. MCS System instrumentation and accessories shall be provided by the OEM. OEM to coordinate with Contractor and Instrumentation Supplier. Conduit and wiring between instrumentation and MCS shall be provided by OEM. Conduit and wiring shall comply with Division 26 and 409XXX series specifications.

G. Water Heaters:
1. OEM shall provide the heaters. OEM to coordinate with MCS Tank Supplier.
2. Sizes: Per the equipment schedule.
3. Material: 304 SST flange and Incoloy sheath.
4. Electrical Characteristics: 480V, 3 phase, cold section first 10 inches. Include thermostat.
5. The heater shall have a maximum temperature thermostat switch to prevent excessive heating and damage to the tank.
6. Installation: Per the manufacturer's recommendations.
7. Manufacturer: Indeeco, Chromalox, or Engineer Approved Equal.

2.10 PERMEATE FLUSH SYSTEM

A. Permeate Flush System (PFS): OEM shall provide the permeate flush system (where indicated) which shall include tank(s), pump(s), valves, meters, and controls as indicated on the drawings.

B. Permeate Flush Tanks(s)
1. Permeate Flush Tank(s) are specified in Division 46, Section "Polyethylene Chemical Storage Tanks and Appurtenances". These tanks to be provided by the Contractor. OEM to coordinate with Contractor and Permeate Flush Tank Supplier.

C. Piping

1. Permeate Flush Piping is specified in Division 40 Section “Process Piping”. MCS piping shall be provided and assembled by the Contractor. Skidded Permeate Flush systems are not acceptable.

D. Valves
1. Permeate Flush valves are specified in Division 40, Section “Process Valves, Gates, and Accessories”. Permeate Flush valves shall be provided by the Contractor. OEM to coordinate with Permeate Flush Valve Supplier.

E. Pump(s)
1. Permeate Flush Pump(s) are specified in Division 43, Section “Horizontal End Suction Pumps”. These pumps shall be provided by the Contractor.

F. Instrumentation/Accessories
1. Permeate Flush System instrumentation and accessories shall be provided by the OEM.

2.11 ACCESSORIES

A. SDI Test Apparatus
1. Provide and install one silt density index (SDI) test apparatus for each array at the sample panel.
2. SDI test apparatus shall conform to the requirements of ASTM D4189.
3. Provide 500 filters with each apparatus.

2.12 IDENTIFICATION

A. Identify all equipment per Division 40 Section “Process Valves, Gates, and Accessories”.

B. Identification Schedule
1. Identify all valves on each skid. Valve numbers are listed in the valve schedule.
2. Identify all piping using the language indicated on the drawings.
3. For cleaning connections, provide placards mounted on the piping showing and describing the valve settings for cleaning both stages.
4. Identify each pressure vessel. Locate the label on the side of the pressure vessel facing the sample sink and at the front of the skid. Pressure vessel numbering shall correspond to the sample valve numbering.
5. Identify each pressure gauge, transmitter, flow element, analytical element, and all other pieces of equipment. Tag shall be descriptive of the equipment, i.e. “1ST STAGE FEED PRESSURE”.

2.13 ELECTRICAL

A. Refer to Division 26 - Electrical for Electrical Requirements.

B. Conduit
1. All on skid electrical and control conduits shall be schedule 80 PVC conduit in accordance with Division 26, Section “Raceway.”

2.14 CONTROL PANELS

A. OEM shall provide the following control panels:

1. NF Skids Master Control Panel (NF-MCP)
2. NF Skid Control Panels (NF1, NF2, NF3, etc….)
3. NF MCS Control Panel (MCS-CP)

B. Control Panels and components shall be in accordance with Division 40, Section 409XXX series and as shown on the drawings.

C. MCS Control Panel (NF-MCSCP)
1. Provide VFDs for each MCS Pump (MCSP-1 and MCSP-2) and Permeate Flush Pump (PFP-1).
   a. VFDs shall be in accordance with Division 26, Section "Variable Frequency Drives".
2. Provide local on/off switches for operation of the heaters.

D. Provide spare parts for control panel components as specified in Section 409XXX series.

2.15 CONTROLS

A. Provide controls for all elements scope supplied. All instrumentation required to control and monitor the operation of the equipment shall be provided including all PLC and OIT programming for all supplied equipment.

B. OEM shall control the NF Feed Pumps (NFFPs).
1. There will be one (1) feed pump for each NF skid.
2. NF feed pumps are VFD driven.
3. NF-MCP shall control the VFD to slowly adjust the pump flow rate to desired setpoint.

C. Provide an electronic copy of the software on a USB jump drive to allow the customer to reconfigure the program. The software provided to the customer shall be the "As-Built" version of the operating program that includes all start up and on-site changes that were made to the original program.

D. Control components, where specified within this section, shall be provided under this section.

E. The equipment specified under this section shall operate manually/automatically as shown on the drawings and specified in Section 409XXX. Any additional materials of equipment required by this section's OEM, but not shown on the drawings or specified in sections 409XXX, to allow this equipment to function in the required manner, shall be furnished and installed under this section.

F. Provide all miscellaneous supports, brackets, fasteners, and fabrications required to mount and install equipment controls provided under this section.

2.16 NF CONTROL DESCRIPTION

A. The controls shall be designed to operate and control the NF Skids, NFFPs, MCS system, and Permeate Flush System.

B. The permeate flux and recovery shall be adjustable such that the skid can be programmed to make different amounts of permeate. OEM shall program the skids to operate at varying capacities by adjusting the permeate flux and recovery.

C. NF Flow Calculations
   1. Operator shall have the ability to enter the desired NF flux rate (gfd) and percent recovery (%) for each NF skid.
   2. Operator shall have the ability to enter the number of pressure vessels in the first stage (#PV1) and second stage (#PV2), number of elements per vessel (#EL), and square footage of membrane area per element (AEL) for each NF Skid. #EL and AEL shall be a common input at one location for all skids.
   3. Indicate the Total #PV (#PV1 + #PV2).
   4. Indicate NF Permeate Flow (NFP = #PV x AEL x Flux)
   5. Indicate NF Feed Flow (NFF = NFP / % recovery)
   6. Indicate NF Concentrate Flow (NFC = NFF – NFP)
   7. Indicate 2nd Stage NF Concentrate flow per pressure vessel:
      a. NFCPV2nd = NFC / #PV2nd
      b. If NFCPV2nd < 15, then provide alarm stating “Minimum 2nd Stage NFC flow per Pressure Vessel too low. Lower % recovery or raise flux.”

D. Communicate all parameters with the Plant SCADA system (PCS). Refer to Division 40, Section “Plant Control System” for a description of the plant operation.

E. General
   1. The following control function description is preliminary; final design, detailing, and implementation of control strategy will be performed by the OEM.
   2. All skids will be controlled by NF-MCP which will receive run/shutdown signals from the NF Building ACP (NF-ACP). NF-MCP will also receive the number of NF skids to be in service. Interface with NF-ACP must be coordinated with the System Integrator.
   3. All control functions on the skids shall have Local Automatic, Remote Automatic, Off, and manual override. Manual control shall be limited to authorized personnel only and shall not be selectable from the face of the control panel. Remote/local selection shall apply to the overall start and stop function only, and shall not interfere with manual/auto operation of individual components, except where necessary safeties apply.
      a. Remote position of selector permits the skid to receive the plant run signal from the NF-ACP.
      b. Local position of selector inhibits the skid from receiving the plant run signal from the PCS.
      c. All NF skid components must be capable of manual operation, but manual controls shall not be located individually at the NF Skid Control Panel (NF1, NF2, NF3, etc…)

F. Start Sequence
   1. Start signal will be sent from the NF-ACP to NF-MCP. The number of NF skids in service will be sent from the NF-MCP to NF-ACP. Only one skid shall start at a time. Only one skid shall shutdown at a time (except for alarm conditions).
   2. Pre-Flush
      a. Open the NF concentrate (NFC) throttling valve 100%.
      b. Close NF permeate (NFP) valve and open NF permeate dump (NFD) valve.
      c. Start the NF feed pump at 25% and increase speed to obtain pre-programmed concentrate flow rate.
      d. At the end of the pre-flush period, open the NF permeate (NFP) valve and close the NF permeate dump (NFD) valve. Valves shall be programmed to open/close slowly over 1 minute). Turn control over to the PID loops.
      e. If pre-flush continues beyond an operator adjustable duration, initiate alarm.

G. Permeate Flush System (if equipped)
   1. Permeate Flush system shall be operated as described below during permeate flushing:
      a. Permeate Flush tank fill shall be automatically controlled. Tank fill shall be accomplished using the Permeate Flush Tank fill valve, and the Permeate Flush Tank tank level sensor. The Permeate Flush System tank level sensor shall include operator adjustable setpoints for pump cut off, low water level, fill, and high water level.
      b. Flush shall be performed as described under normal shutdown sequence. NF PLC to control all valving on the skid being flushed as well as the Permeate Flush Pump on/off and speed.

H. MCS System
   1. MCS system shall be operated as described below during membrane cleaning:
      a. Skid to be cleaned shall be locked out from running via a HMI selector switch on any of the OITs. All automatic valves on the skid shall be automatically placed in the appropriate position for cleaning.
      b. MCS tank fill will be manually controlled.
      c. MCS tank water shall be automatically heated. Heating shall be accomplished using the heater. An operator adjustable setpoint shall be used to set the desired heated water temperature. An operator adjustable setpoint shall be included for a high temperature alarm. Heating is initiated using an operator controlled on/off/auto switch.
      d. Once the MCS tank water is heated, the operator will manually add chemical (either in the top of the tank or using the eductor) and manually start the MCS pump using the on/off/auto switch. Operator will manually throttle the flow by observing the flowrate and controlling the VFD speed on the MCS pump.

I. Normal Run Operation
   1. Start the selected skid (one at a time). NF-MCP shall automatically rotate the skids and shall display the accumulated skid runtime. If any skid has not ran for an operator selectable duration, provide an alarm indicating that the skids have to be rotated.
   2. The operator shall be able to exclude each skid from running using a selector switch on any of the OITs. Each skid shall be started at 50% of design capacity and ran for 60 seconds before increasing slowly to the desired flow rate setting.
   3. Permeate Flow Control: The feed flow meter controls the feed pump VFD to maintain the preset flowrate.
   4. Concentrate Flow Control: Concentrate flowmeter controls the concentrate control valve to maintain the pre-set concentrate flow rate.
   5. Flow rates, pressures, and conductivities shall be monitored by the NF skid system controller. If any parameter goes beyond pre-set limits for more than an allowable time, it will indicate on the control panel and send a general alarm to the plant control system.
   6. If ORP exceeds setpoint, shut down the skid.

J. Normal Shutdown
   1. Stop signal will be sent from the NF-ACP to NF-MCP. The number of NF skids in service will be sent from the NF-MCP to NF-ACP. Only one skid shall stop at a time.
   2. Post-flush
      a. System shall be set up for flushing with feed water (forward flush) or Permeate Flush (if equipped). If equipped, an operator adjustable selector switch shall indicate which flushing water source is to be used (forward flush or permeate flush).

b. Control the NF feed pump or the permeate flush pump and/or the NF concentrate (NFC) control valve speed to obtain operator adjustable concentrate flow rate during the flush.
c. Open NF permeate dump (NFD) valve and close NF permeate (NFP) valve.
d. Open NF concentrate (NFC) valve 100%.
e. Continue post-flush for an operator adjustable setpoint duration.
f. Stop the NF feed pump or the Permeate Flush Pump.
g. Close the NF feed valve.

K. Emergency Shutdown (Loss of Power): The emergency shutdown sequence shall be identical to the normal shutdown except that it is initiated by the shutdown logic rather than the operator.
1. All skids stop.
2. NFC valve fails open.
3. NFD valve fails open.
4. No automatic restart of feed pumps or skids.

L. Alarms and Shutdown (Internal Logic): There are a variety of conditions listed below which must be verified prior to proceeding with the next step in a start-up or shutdown sequence. These will be defined by the Engineer in conjunction with the OEM following contract award. Should any of these conditions be detected, the NF-MCP PLC shall issue an alarm indicating the failing equipment or permissive that caused the fault, and halt the sequence. If in automatic sequencing, the PLC shall shutdown the skid. If in manual sequencing, the PLC shall either proceed or shutdown the skid as directed by the operator via the OIT. The discrepancy alarm shall describe the condition which caused it in sufficient detail for the operator to investigate and correct the problem.
1. pH out of range: Alarm in main control system.
2. NF feed suction low pressure: alarm and skid shutdown with post-flush.
3. Antiscalant low tank level: Alarm and normal plant shutdown (in main control system).
4. Antiscalant no flow: Alarm and normal plant shutdown (in main control system).
5. High permeate pressure on each skid: Shut down skid with post-flush.
6. Cartridge filter high differential pressure: Alarm in main control system.
7. NF Feed pump high pressure: Alarm and shut down with post-flush.
8. Failure of valve to reach specified position: Alarm.
9. High permeate conductivity: Alarm.
10. Permeate valve and permeate dump valve both closed: Shutdown with post-flush.
11. Concentrate valve closed: Shutdown, no post-flush.
12. Low concentrate flow: Shutdown with post-flush.
13. NF skid rotation: Alarm.

M. Include a performance monitoring software system for purposes of:
1. Automatic data acquisition
2. Data trending
3. Report generation
4. Alarm management including notification and alarm archiving
5. Remote web access to view data trending and reports
6. Facilitating system performance analysis
7. Facilitating performance optimization
8. Refer to Part 3 “Service Agreement and Remote Monitoring”

PART 3 - EXECUTION

3.1 INSTALLATION OF MEMBRANE ELEMENTS

A. Conform to the requirements of Division 01, Section “Quality Control”, paragraph 1.8, Manufacturer's Field Services.

B. Installation work shall conform to the Membrane Manufacturer’s recommended procedures, instructions, and approved loading sequence.

C. Provide for the services of a factory trained service technician of the membrane manufacturer to be present to supervise the installation of the membranes.

3.2 FACTORY ACCEPTANCE TESTING

A. After final assembly is complete and prior to being shipped, each fully assembled skid shall undergo factor acceptance testing. All piping, pressure vessels, and associated appurtenances shall be testing to 150% of their maximum operating pressures. Any leaks, if discovered, shall be repaired, and factory acceptance testing shall be redone. OEM shall submit results of factory acceptance testing for approval. If desired by the Owner and/or Engineer, factory acceptance testing will be witnessed, in-person. OEM shall give written notice to Engineer no less than thirty (30) days prior to factory acceptance testing. OEM is not responsible for travel, lodging, or meal costs for the Owner or Engineer.

3.3 SPECIAL SERVICES

A. Conform to the requirements of Division 01, Section “Quality Control”, paragraph 1.8, Manufacturer's Field Services.

B. Follow the manufacturer's recommended procedures for testing, adjusting, and placing of equipment into proper operation.

C. Startup and Commissioning
   1. Functional Testing
      a. Functional testing of the membrane system shall be accomplished for each membrane skid with test orifices installed in the permeate ports of each vessel to simulate pressure drops. Skid to be operated at representative flows with automatic instrument control as required to confirm responsiveness over design operating range. Testing shall continue until each skid can be run for four consecutive hours without interruption. Two successful start-up and shutdown sequences shall be demonstrated prior to the start of the four-hour test. Demonstration of correct control loop operation in conjunction with CPI loop testing is also required.
      b. At the conclusion of the functional testing the vessels shall be disinfected, cleaned with a manufacturers recommended detergent, and flushed to ensure vessel cleanliness. Vessel interior surfaces shall be thoroughly wiped prior to the loading of the membranes. During membrane loading the brine seals, O-rings, connectors, anti-telescoping devices, and physical condition of the module wrap shall be inspected. Serial numbers and pressure vessel location of each membrane element shall be documented, tabulated and provided to the Engineer for review.
   2. Start-up Testing: Each membrane skid shall be started up, one at a time, and operated for a total of eight hours over a two-day period at design conditions. During this time two bacteriological samples (permeate) shall be taken and tested for heterotrophic plate count

(HPC). Acceptance shall be based upon bacteriological testing of permeate samples showing HPC less than 500 colony forming units per milliliter (CFU/ml). All samples shall be analyzed by an Ohio EPA certified laboratory.

3. Performance Testing
   a. Time of Performance Testing: The performance testing for the membrane system shall occur following completion of all facilities and equipment required for the testing. Final acceptance of the membrane system will be contingent upon successful performance testing. Performance testing of each train must be initiated within 60 days of bacteriological testing during startup.
   b. Testing Protocol: The OEM shall submit a proposed testing protocol 60 days prior to the initiation of the membrane system performance testing. The testing protocol shall have written approval by the Engineer prior to commencement of the testing program. The testing protocol shall include, but not be limited to, water quality sampling parameters, sampling locations, projected dates of the performance testing, Ohio EPA approved laboratory to be used for the water sample analysis, and time of sampling relative to time zero. Time zero for the membrane system performance testing is the time of the first sample.
   c. Duration of Performance Test: Each membrane skid shall be tested for four (4) consecutive days. Two (2) skids may be tested at a time. The OEM shall be fully responsible for every aspect of the performance test. Representatives of the OEM and shall be on site during the entire performance test. Representatives of the Engineer and Owner may also be present during the performance test.
   d. Performance Test Conditions: Each membrane skid shall be tested under design operating conditions.
   e. Data Collection During Performance Test: The following continuous data shall be collected hourly unless otherwise specified during the performance testing:
      1) Water Quality: feed water temperature, feed water conductivity, feed water pH, permeate temperature, permeate conductivity, permeate pH, concentrate conductivity, feed water SDI (twice daily), feed water turbidity, concentrate pH. Temperature, pH, and turbidity readings may be taken from the plant instrumentation provided the instrumentation is operable and calibrated at the time of the test.
      2) A Heterotrophic Plate Count sample shall be taken from the raw water, feed water, interstage feed, concentrate, and permeate within 4 hours after initial startup for each train and repeated just prior to the completion of the performance test. Samples and cultures of samples shall be in accordance with AWWA Standard Methods, current edition.
      3) Mechanical Data: feed water pressure, interstage pressure, permeate pressure, permeate flow, concentrate flow, flow control valve position, concentrate valve position, wells, operating, startup and shutdown times, chemical flow rates and dosages.
   f. Discrete Water Sampling: Samples shall be once per day during the four-day testing for a total of 4 sampling events. During a sampling event, the OEM shall take discrete water samples from the skid's feed, permeate, and concentrate streams for calcium, magnesium, total hardness, sodium, potassium, iron, manganese, barium, strontium, alkalinity, chlorides, sulfates, sulfides, nitrates, nitrites, fluoride, silica, pH, and total dissolved solids. The OEM shall submit samples to an Ohio EPA approved laboratory for analysis. All analytical results shall be transmitted to the OEM and Engineer.
   g. Test Report: A formal bound report shall be produced and submitted to the Engineer for all testing activities. Report shall contain detailed test plans and

results for all activities performed during testing. Results from all testing shall be tabulated, trended, and graphed as appropriate. Discussion of testing, along with conclusions and recommendations, shall be presented in the test report. All laboratory analyses shall be bound into the report as appendices.

4. Field Representative: The OEM shall provide the services of a qualified field representative for all startup and commissioning procedures. The representative shall perform all testing, operation, and debugging of the systems.
5. Training
    a. The OEM shall provide the services of a qualified representative for 5 days to instruct the Owner's personnel on proper operation, installation, sampling, cleaning, and maintenance for the membrane system.
        1) General Background: Ions, organics, bacteria, fungi, algae, sand, silt, clay, colloids, principles of diffusion, dissolved substances, and suspended substances. How nanofiltration works, Principles of net driving pressure. Semipermeable membranes, cellulosic and non-cellulosic. How membranes reject ions, organics, and particles. How NF elements are made and how they work.
        2) NF Skid Operation: The internal and external pieces of a nanofiltration skid. What happens inside the nanofiltration skid. Problems caused by dissolved substances. Why and how scaling and chemical attack occur. Problems caused by suspended substances. Why and how fouling by bacteria and inorganic particles occur. Pretreatment equipment and chemicals used to minimize operating problems. Monitoring techniques such as permeate flow normalization, percent salt rejection, pressure drops, and silt density index to detect problems.
        3) Maintenance: Issues involving the maintenance of the NF skids.
        4) Controls/operation of this specific installation including touch screens, logic, and operations.
6. The OEM shall provide at least two (2) qualified field representatives to be on-site to coordinate and supervise the installation (1 week) and startup and commissioning (3 weeks) of the NF system for each WTP facility. Some time may be combined with that required for the other equipment provided by the OEM.

D. Remote Monitoring: The OEM shall provide two (2) years of monitoring of all of the system operating parameters. Owner to provide OEM will required data (VPN connection is not permitted). The OEM shall provide a monthly status report with a complete analysis of all normalized data with recommendations for operation and maintenance. The period of remote monitoring shall commence upon Substantial Completion of the project.

E. Field Service Agreement: The OEM shall provide a two (2) year service agreement to the Owner. Service agreement shall include all costs (including labor, travel, lodging, meals, and incidentals) for the following for each WTP facility:
    1. Two (2) trips for a qualified field representative to be on-site to assist the Owner in troubleshooting and/or operation of the Nanofiltration Membrane Equipment. Each trip shall consist of four (4) full days of service. Travel days excluded from number of days of service.
    2. Two (2) trips for a qualified field representative to be on-site to assist the Owner in performing membrane cleaning. Each trip shall consist of three (3) full days of service. Travel days excluded from number of days of service.

END OF SECTION 46 6340

RARWTP RO MEMBRANE EQUIPMENT SCHEDULE

A. Performance Requirements
   1. The raw water source is groundwater from wells which has been oxidized with sodium hypochlorite, filtered with gravity filters, and chemically conditioned to reduce ORP and provide antiscalant. Table 1 presents the water quality data which shall be used in the development of the RO system design.
   2. Each NF train shall meet the permeate quality requirements specified in Table 1 throughout the performance warranty period while operating at the design recovery and permeate flowrate.

Table 1 – RARWTP Water Quality Data

Parameter	Unit	Raw Water	Permeate Requirements
NH4+ +NH3	mg/L	0.00	
K	mg/L	2.9	
Na	mg/L	33	
Mg	mg/L	27	
Ca	mg/L	102	
TH	mg/L as CaCO3	366	< 15
Sr	mg/L	0.33	
Ba	mg/L	0.10	
CO3	mg/L	0.27	
HCO3	mg/L	310	
NO3	mg/L	0.56	
Cl	mg/L	63	< 10
F	mg/L	0.20	
SO4	mg/L	52.00	> 0.40
SiO2	mg/L	6.30	
Boron	mg/L	0.00	
TDS	mg/L	597.56	< 30
pH	s.u.	7.11	
Temperature	Degrees F	55-60	

B. NF Skid Design:
   1. No. of Skids: Six (6)
   2. Configuration: 2 Stage, 24:12
   3. No. of Elements per Vessel: 7
   4. Permeate Capacity: 1,030 gpm
   5. Recovery: 80% (adjustable from 70% to 83% to maintain min. concentrate flow of 15 gpm/vessel and a maximum membrane recovery of 19% per element)
   6. Flux: 14.7 gfd
   7. Permeate Backpressure after skid:
      a. Stage 1: 0-35 psig (adjustable)
      b. Stage 2: 0-15 psig

C. NF Skid Dimensions:
   1. Maximum Width: 95 inches (8’-0”)
   2. Maximum Length: 318 inches (26’-6”)
   3. Maximum Height: 150 inches (12’-6”)

D. MCS:
   1. Stage 1
      a. Heater: 120 kW
   2. Stage 2
      a. Heater: 75 kW

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SECTION 46 6342

SIDE-PORTED PRESSURE VESSELS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section, including but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this section includes furnishing and installation of all equipment necessary to provide the side-ported pressure vessels for the NF system.

B. Equipment specified under this section shall be provided by the ROEM as part of the membrane treatment system.

C. Equipment furnished and installed under this section shall be fabricated, assembled, erected and placed in proper operating condition in full compliance with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: All pressure vessels specified under this section shall be manufactured and supplied by one manufacturer.

B. Reference Standards: The pressure vessel design must meet all the requirements of ASME Section X, entitled Fiber Reinforced Boilers and Pressure Vessels.

1.4 SUBMITTALS

A. The manufacturer shall provide instructions on installation, operation and maintenance and proper application of the vessels as well as a vessel drawing. Submittals shall conform to the requirements set forth by Division 01 Section "Submittal Procedures". The documents provided shall include the following:
   1. Operation and Maintenance Instructions: Step-by-step instructions for opening and closing the vessel along with precautions and recommended maintenance procedures. These instructions shall be written to inform a general mechanic unfamiliar with NF vessels.
   2. Installation Instructions: Detailed instructions for handling, mounting and connecting the vessel.
   3. Application Guide: General guidelines to assist the NF system engineer to apply vessels correctly to the specific requirements.
   4. Engineering Drawing: detailed drawings that specify all parameters necessary to incorporate the vessel component into the NF system, including dimensions, weights, materials of construction and port size.

1.5 SPARE PARTS

A. Spare parts shall be of the same manufacture and quality as those provided with the equipment. Spare parts shall be suitably packaged in accordance with the Manufacturer's recommendations, with labels indicating the contents of each package. Spare parts shall be delivered to the Owner with the equipment of this Section.

B. Provide the following spare parts:
   1. 2 complete pressure vessel heads.

1.6 HANDLING, DELIVERY, AND STORAGE

A. The pressure vessels shall be completely factory assembled and securely crated for shipment.

B. When received at the site, the pressure vessels shall be stored in a clean, dry environment until ready for installation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Pressure vessels shall have a diameter and length designed specifically to contain a quantity of 7 standard eight-inch diameter by 40-inch long spiral-wound membrane elements. The feed and concentrate ports shall be located in the sidewall of the pressure vessel. Vessels with multiple ports per end for direct vessel-to-vessel connection are permitted and required in order to simplify system design, provide a smaller footprint and eliminate excessive manifolds.

B. Vessels shall have a maximum working pressure of not less than 200 PSI at a temperature up to 120 deg F (49 deg C) with a minimum operating temperature of not less than 20 deg F (-7 deg C).

C. Vessels shall be complete with end closures, hardware and membrane element end adapters. Membrane elements and membrane interconnectors shall be furnished by the membrane element manufacturer.

D. The adapters furnished shall be appropriate for the brand of membrane element specified. In addition, the vessel shall be designed to allow other makes of membrane elements to be easily accommodated by changing the adapters.

E. The materials used in the construction of the pressure vessel shall meet ASME code requirements, including material selection and required strength for the anticipated operating conditions. These materials shall also have the following characteristics:
   1. All wetted head components in continuous contact with the pressurized process water shall be made from plastics that are known to have long-term resistance to corrosion in the service intended.
   2. All wetted nozzles in continuous contact with the pressurized process water shall be made from wrought pipe that is known to have long-term resistance to corrosion in the service intended.
   3. All other materials of construction shall be of appropriate strength and corrosion resistance for the operating conditions. The use of an unanodized aluminum and plastic load bearing materials is strictly prohibited.

4. The materials of construction for each component part of the vessel shall be clearly and fully specified on the Engineering Drawing.

F. Manufacturer: Bekaert Progressive Composites, Codeline, Wave Cyber.

2.2 VESSEL SAFETY

A. Vessels shall be designed to meet the standards of ASME Boiler and Pressure Vessel Code, Section X. Vessels shall be certified by manufacturer. Code stamp is not required.
   1. The Manufacturer shall be qualified to produce Code Certifiable Pressure Vessels per Section X of the Code as verified by possession of a current Certificate of Authorization issued by the ASME.
   2. Vessels shall be built to a design that has been qualified for fabrication through ASME Design and Procedure Qualification Tests. The tests include destructive pressure tests of prototype vessels. To qualify, a prototype must not burst at less than six times (6X) its rated pressure after being pressure cycled 100,000 times at 150 deg F.
   3. Vessels shall be fabricated so as to duplicate the qualified design through compliance with the ASME approved Procedure Specification written for the prototype. Proof of conformance is established through the workings of the ASME approved Quality Control System.
   4. Vessels shall be tested to assure conformance with the qualified design through ASME Quality Control and Production Tests. Each vessel undergoes ASME Production Tests, which include a Hydrostatic Leakage Test, at a pressure of 1.1 times the rated pressure.
   5. A third party ASME Authorized Inspector shall inspect vessels during fabrication in order to assure conformance with the qualified design.
   6. The materials shall be approved for use in pressure vessel construction by the standards of the ASME Boiler and Pressure Vessel Code. Such materials shall meet the following criteria:
      a. Materials of construction shall be certified by the manufacturer to meet Code standards where applicable and shall be lot traceable to the vessel serial number.

2.3 VESSEL SHELL

A. Pressure vessels shall be designed for ease of use and fail-safe operation. The vessels shall include the following:
   1. In order to provide superior long-term strength, the locking ring groove shall be integrally filament wound into the I. D. of the vessel. In addition, each grove shall incorporate an integrally wound 316L stainless steel insert for added groove durability and improved corrosion resistance. Cutting or grinding of fibers to form the locking ring groove is not acceptable as this may weaken the shell and directly affect the safety and service life of the vessel.
   2. The shell bore shall be fabricated from a resin-rich epoxy barrier that has been cured to allow for superior corrosion resistance, minimal extractables, improved life and high temperature (176 deg F/80 deg C) operation. Winding over plastic pipe is not acceptable under any circumstance.
   3. The shell of the vessel shall be fabricated of filament-wound fiberglass reinforced plastic (FWFRP) using continuous glass roving, impregnated with an elevated temperature cure epoxy resin system to provide superior dimensional stability and long term service life. The use of single monomer resin such as polyester is strictly prohibited.
   4. Each shell inside diameter shall be free of pits or voids that may promote bacterial growth or corrosive attack of the resin-rich barrier and shall conform to level 1 criteria as

ASME Section X, section 6-100.1. The bore diameter shall be a mirror-like, smooth surface and meet the following measurement criteria throughout the membrane interface area:

Nominal 8-inch diameter 7.955 ± .005.

5. Each shell shall have an exterior surface that has been coated with a two-part polyurethane enamel for superior gloss retention, abrasion resistance and to block light that may promote biological growth. Each end-bell shall be free of any grinding or sanding marks. The length of the shell between the bells shall be straight without any lumpiness that may indicate filament-winding inconsistency that could affect performance.
6. The shell shall be fail-safe to prevent catastrophic failure while in service. The head retention system shall fail at a nominal value of not less than 6 times design pressure to prevent the possibility of catastrophic failure while in service.

2.4 VESSEL HEAD

A. Each vessel head shall be designed for removal by hand under normal operating conditions. In addition, each head shall feature a secondary removal means (such as female threads) to assist in head removal as required throughout the service life of the vessel.

B. Each vessel head shall be constructed from ASME approved metal materials for indirect load bearing applications. The use of thermoplastics for direct load bearing applications is strictly prohibited.

C. The primary means for head retention shall be a single retaining mechanism that provides ASME-required redundancy and is constructed of stainless steel for ease of use and long term reliability and shall be able to be removed by hand, without the use of any tools to reduce operation and maintenance costs.

D. Each head shall contain an integral stainless steel secondary interlock that requires a simple, yet specific sequence of events to remove the end closure and shall not require the use of separate components that may become separated from the vessel. The use of plastic secondary interlock mechanisms that may become damaged by wear or environmental exposure are prohibited.

E. The surfaces of the head that come in contact with the process fluid shall be constructed from PVC or other inert plastic to eliminate any problems with metal corrosion such as pitting or crevice corrosion.

F. Permeate Port
1. The permeate port shall be 1-1/2-inch NPT male or 1-1/2-inch grooved end, as recommended by the ROEM and as approved by the Engineer.
2. The permeate port shall be constructed from PVC.
3. Each permeate port shall be designed with an anti-rotation mechanism so that piping may be easily tightened.

G. Permeate Sampling Valve
1. The feed end permeate port of each pressure vessel shall be fitted with a 1/4-inch diameter thermoplastic ball valve that has been designed exclusively for membrane probing without excess permeate water loss.

2. The valve shall include a gripper nut that can be easily tightened and loosened by hand throughout the probing process.
3. The nut ferrule shall include an o-ring seal to prevent leakage during operation.
4. The valve shall be attached to the permeate port with a 1/4-inch 316 stainless steel nipple.

2.5 VESSEL SIDE PORTS

A. Each side-ported feed/concentrate port shall be 2-1/2-inch diameter and constructed of wrought stainless steel pipe and shall be designed to interface the flexible grooved coupling. The port shall be marked for complete traceability with the part number and the heat lot of the material that can be traced to batch related corrosion test performance. The use of investment cast materials is prohibited.

B. Each side-ported feed/concentrate port shall be designed so that they may be removed and replaced in the field by the end user without the use of special tools.

C. The use of multiple ported vessels that allow direct vessel to vessel connections is permitted providing the following provisions are met:
1. No more than three pressure vessels shall be connected to one feed/concentrate manifold connection without approval.
2. The pressure drop between each connected set of three vessels shall not have a pressure differential in excess of 3 PSI.
3. All multiple port connections shall be sized to limit feed water flow velocities to no more than 11 Feet per second. In addition membrane cleaning flow requirements must be considered when multiple porting is to be used.
4. The feed manifold and concentrate manifold shall be located on opposite sides of each set of pressure vessels to ensure correct flow balancing. Design layouts that locate the feed manifold and concentrate manifold on the same side of each set of pressure vessels shall not be used without prior approval of the Engineer.

D. Each side-ported feed/concentrate port shall be completely flush with the inside surface of the vessel so as to not interfere with membrane element loading. Ports that are in any way raised into the interior surface of the vessel shall not be acceptable.

E. Each side port shall feature a direct metal to composite interface. The compression loading of any non-code material, such as thermoplastic that may creep under pressure, is not permitted.

2.6 VESSEL SEALS

A. In order to assure field serviceability, all seals, whether in the shell or head, shall be visible so as to be directly accessible for replacement without the removal of any other components. Seal designs that do not eliminate dead space and may lead to biological growth are strictly prohibited.

B. All permeate connection seals shall be designed to prevent rolling that may lead to seal damage.

C. All permeate connection seals shall be peroxide-cured ethylene propylene (EPDM) rubber to increase seal life and reduce the effects of permanent compression set.

D. Vessels shall not leak when properly installed. If leaking occurs, the vessel supplier is responsible for the repair or replacement of the vessel. Such leaking must be remedied within 14 working days from the notification of the leak.

E. Each Head Seal shall be so designed to minimize cross sectional thickness to reduce the friction required for head installation and removal.

F. Each head seal gland shall be designed to eliminate dead space and to expose the seal surface to high-pressure fluid for flushing of the seal in order to minimize bacterial growth.

G. Each head seal gland shall be located on the head of the vessel and shall partially capture the seal, so that it remains on the head at all times, even during head removal, without becoming separated from the head, which may cause seal damage, misplacement or vessel leakage.

H. Each side-ported feed/concentrate port shall incorporate an elastomeric seal that seals to vessel shell so that edge laminate surfaces are not exposed. Side port designs that do not eliminate seal dead space and may lead to biological growth are strictly prohibited.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's printed instructions.

B. The NFEM shall provide documentation that the membrane skid piping design allows for expansion and contraction of the pressure vessels and that the system is designed in accordance with the vessels manufacturer's recommendations.

3.2 TESTING

A. After installation, conduct pressure and leakage tests for each vessel as part of the membrane skid tests in accordance with Division 46 Section "Nanofiltration Membrane Equipment".

B. Prior to membrane element installation, thoroughly clean, flush, and disinfect the pressure vessels. All disinfectant solution shall be completely flushed from the pressure vessels prior to membrane element installation.

END OF SECTION 46 6342

BOARD OF COUNTY COMMISSIONERS
WARREN COUNTY, OHIO

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Telephone (513) 695-1250
Facsimile (513) 695-2054

TOM GROSSMANN
SHANNON JONES
DAVID G. YOUNG

ADVERTISEMENT FOR BIDS

Separate sealed bids will be received by the Clerk of the County Commissioners, Warren County, Ohio, 406 Justice Drive, Lebanon, Ohio 45036, until 11:00 AM, Thursday May 28, 2020, at the Office of the Warren County Commissioners, and then at said time bids will be opened and read aloud for the Richard A. Renneker Water Treatment Plant (RARWTP) Membrane Softening Upgrades Project.

Bid documents including terms, general conditions, supplemental conditions and specifications are available online at the Warren County's Website at
https://www.co.warren.oh.us/Commissioners/Bids/Default.aspx

Questions regarding the technical specifications shall be submitted electronically to the Engineer:
Miranda Scheitlin, EI
Miranda.scheitlin@aecom.com
614-600-5804

A non-mandatory pre-bid meeting has been scheduled for May 12, 2020 @ 10:00 a.m. at the Richard A. Renneker Water Treatment Plant, 6193 Striker Road, Hamilton Township, Ohio. The County will review the project requirements with potential bidders, and receive questions. A visit the project site will be conducted after the meeting. Contact the Warren County Commissioners Office at (513) 695-1250 should you need assistance in accessing the bidding information on the County web site.

The project generally consists of the construction of a membrane softening addition to the existing Richard A. Renneker Water Treatment Plant to treat 13.7 MGD (expandable to 22.0 MGD) of groundwater. Improvements include a new nanofiltration softening building complete with NF softening equipment, pumps, process piping, valves, degasifiers, chemical feed systems, al all associated architectural, structural, HVAC, plumbing, electrical, instrumentation and controls work shown on the plans.

The Engineer's opinion of probable construction cost is $26,856,000.

The Board of Warren County Commissioners reserve the right to accept the lowest and best bid, to reject all bids, and to waive any irregularities in bids.

By order of the Board of County Commissioners, Warren County, Ohio.